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THIS IS OUR LAND

This Is Our Land

The Story of Conservation in the United States

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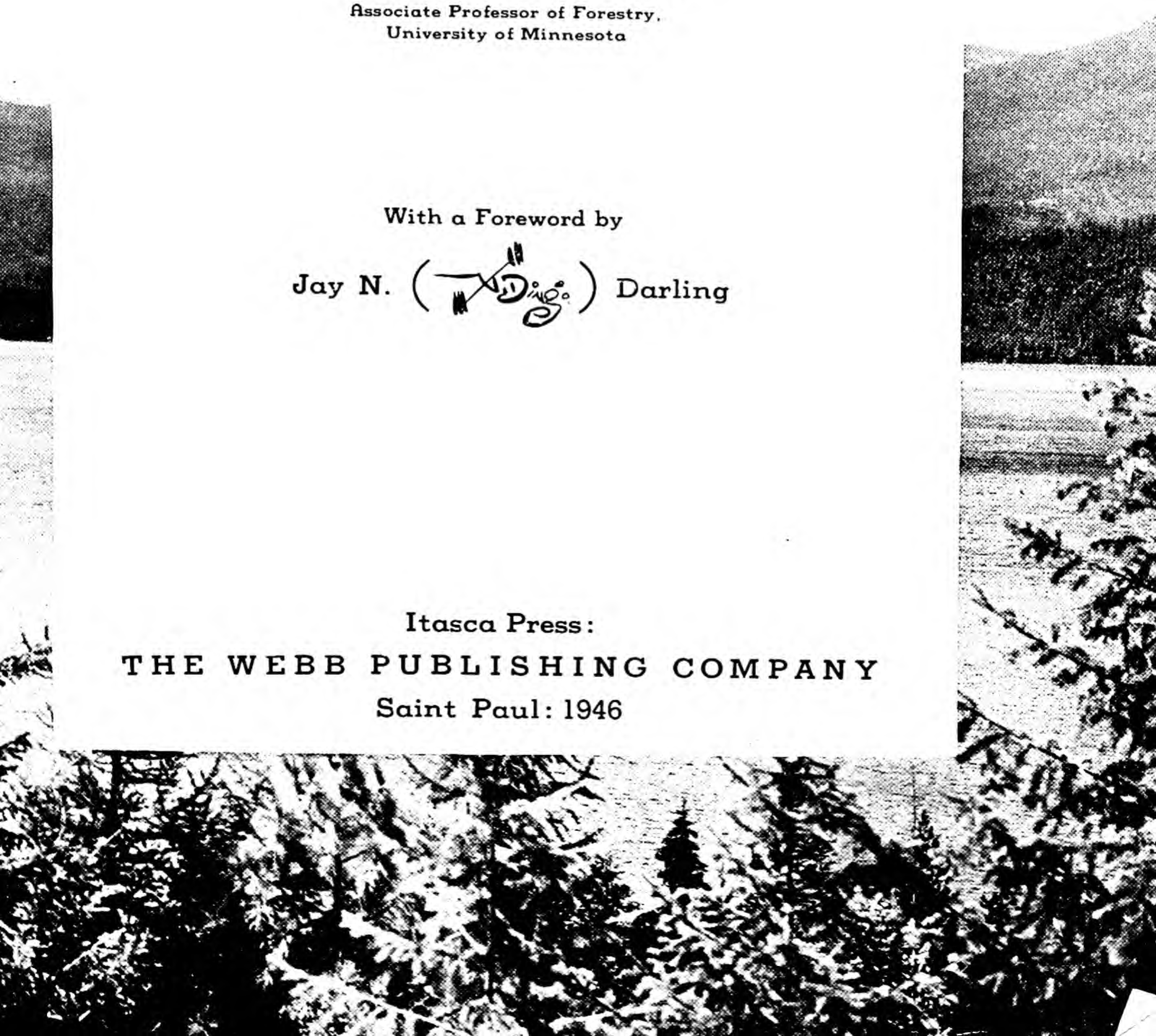

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Preface

IT IS becoming increasingly important that we as a people know the extent, value, and present status of the nation's natural resources. It is equally important that we know how these resources have been used and what should be done to take proper care of them in the future. The welfare of the country in years to come depends in large measure upon our knowledge of the facts pertaining to the loss of resources by waste and the imperative necessity for their wiser use and conservation. The destruction of soil, the extravagant waste of timber, grasslands, minerals, water, and wildlife are alarming and have brought about a wide recognition of the vital need for more effective conservation measures.

The agencies of the Government and many interested organizations have approached the task with earnestness and vigor, but success depends also on the attitude and help of educators and all classes of citizens.

To meet the need for a comprehensive textbook in conservation, the authors have prepared *This Is Our Land.* From the great body of source material available, those facts have been chosen which, it is hoped, will stimulate further interest, wider reading, and, most important, lead to active participation in the conservation movement. An attempt has been made to present the material in interesting form, as free as possible from dry statistics, and generously illustrated with photographs.

For assistance in the preparation of the manuscript, the authors are indebted to many individuals and organizations. They wish to express their appreciation to Dr. Aldo Leopold of the University of Wisconsin, and to Dr. H. K. Wilson and Prof. Wilson Wallis of the University of Minnesota, who reviewed, respectively, the chapters on wildlife, soils, and human

resources; and to Mr. W. T. Cox, widely known forester and authority on game management, for his careful reading of several chapters.

Appreciation is also extended to Mr. Richard C. Davids, editor of the text, who gave unstintingly of his time over a long period both in the organization of the material and in valuable research in connection with many of the subjects covered.

For their co-operation in supplying photographs the authors are grateful to the U. S. Forest Service, the U. S. Soil Conservation Service, the U. S. Department of the Interior, the U. S. Bureau of Mines, the Minnesota Tourist Bureau, and the many other sources listed on page 331.

And, finally, they wish to express their very great appreciation to Mr. Jay N. Darling for his interest in the work, his helpful suggestions, and his challenging Foreword.

It is their hope that this volume may help to bring about a saner and more temperate use of those great natural resources that have been and always must be the foundation of our nation's wealth.

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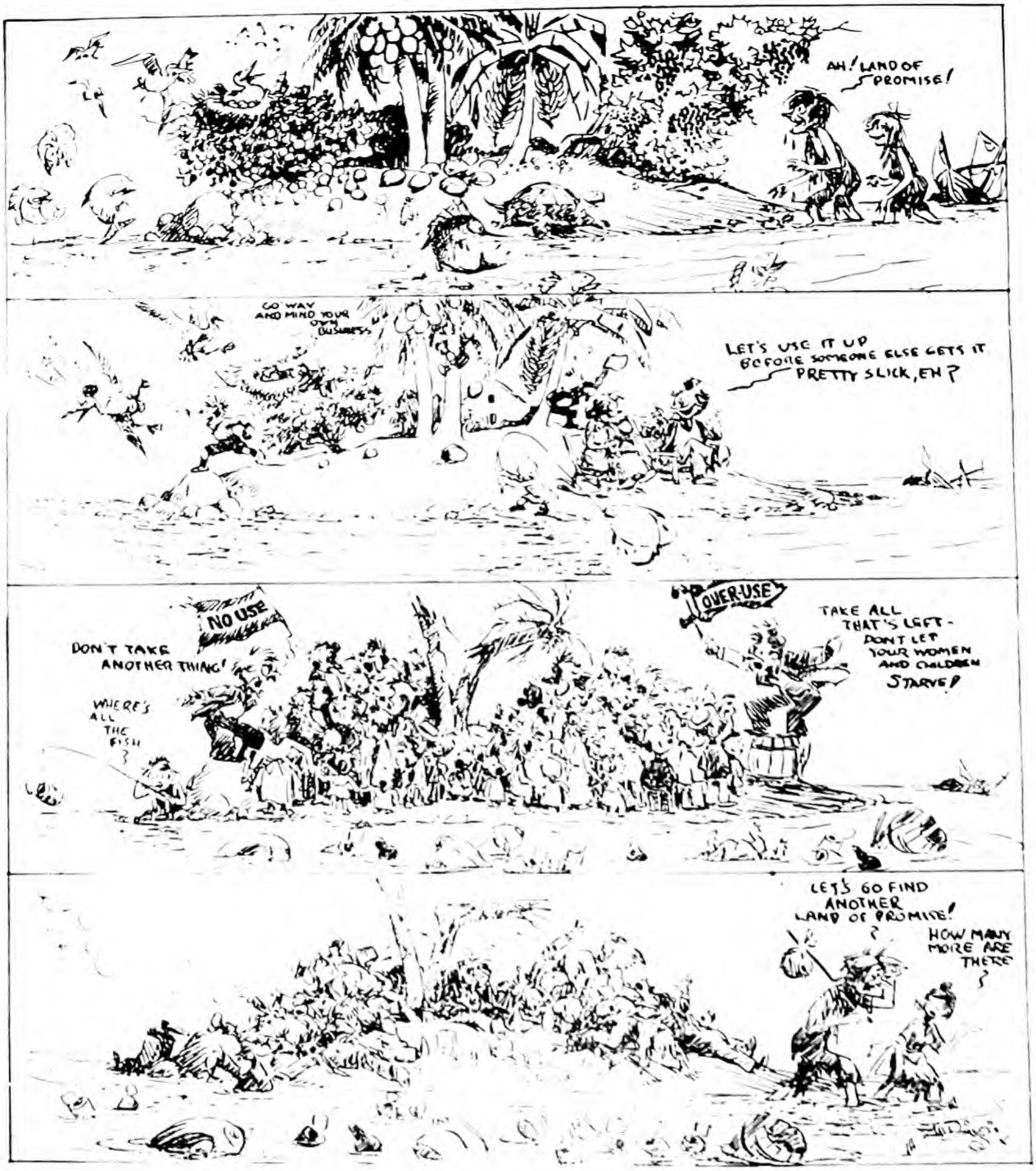


THE OUTLINE OF HISTORY

Foreword

By JAY N. DARLING

IF SOME fine morning we should pick up our newspaper and read that 500 million acres of land in the United States had suddenly sunk into the sea, horror would electrify every nerve cell in our individual and national organisms. What happened to all the people who had been living on that land which had disappeared? Was the loss in valuable resources to our country serious? There would be a traffic jam on every telephone exchange and communication device in the nation in an effort to organize for the emergency.

Five hundred million acres of productive lands have in fact disappeared from the original life-sustaining resources of the United States of America and the people who once lived on this vast area are just as homeless as though their former habitations had sunk into the sea. Dust bowls, abandoned farms, deserted ranches and cut-over forest lands, ghost towns, barren hills, eroding grasslands, and drought constitute a record of eviction of human tenants that outdistances any continental landlord in history over a like period of time.

Only one aspect of the comparison offers a material difference. If the lands had sunk into the sea, the calamity would be over. But the depletion of natural resources is a continuing process and without a change of land management the human problem will increase as the years advance. Anyone who has read *Grapes of Wrath* will agree that the problem is already big enough. The application of the scientific principles of conservation to our natural resources is the one method by which further depletion can be checked and our manmade deserts restored to human use. But conservation has been and still is a voice crying in the wilderness. Like the British pamphlet-bombing of Germany in the interest of peace, this country has been showered with conservation literature as a warning and as a way out. From general appearance the two pamphlet campaigns have been about equally ineffective.

FOREWORD

Anyone who tackles the subject of conservation with a pen must be of strong heart, and courageous, for ere he has told the whole story he will have tramped on many pet corns and stirred up many a hornet's nest. He will find himself about as unpopular as the proverbial bearer of bad news.

The people of America have taken for granted for so many years that our natural resources are abundant and everlasting that exploitation has become a fixed habit of our economic life. To them the inalienable right of life, liberty, and the pursuit of happiness is synonymous with the privilege of ripping from the surface of this continent anything that may be converted into immediate cash, regardless of the consequences to future generations. Any attempt to restrict or limit the obvious abuses of this privilege is about as easy as trying to take a jar of honey away from a grizzly bear.

In principle, conservation is entirely convincing and universally accepted. In practice, the principles are just as universally discarded in favor of quick profits and the devil take the future consequences.

Because of this heedlessness, an estimated population greater than our present army of unemployed has been evicted from areas in the United States on which millions of men and their families once lived in comparative comfort and plenty. More than fifty million acres of tillable soil, 340 million acres of grassland, and two thirds of our native forest areas are now ghostly relics of former human habitation. Our depleted commercial fishing waters are greater in area than the denuded forests.

Where have the millions of men and their families gone who once inhabited those lands, now deserted?

Certainly they can no longer find location on new frontiers in the United States: we have no new frontiers left.

Mostly they have gone to the industrial centers and demanded jobs, much faster than industry could absorb them. (Industry has expanded, but not as fast as tillable soils and forests receded.) Or they became drifters on the highways, with their meager belongings tied to a rickety auto derelict. A great majority became problems for our economic crackpots who, without a glance at the obvious source of this social epidemic, declared that "capitalism is a failure," "democracy is a worn-out form of govern-

ment" or "big business and its greed have starved these pitiful human spectacles out of their right to work for a living."

Quite frankly, the shrinkage of the producing areas in the United States has bankrupted as great a ratio of so-called capitalists as it has little farmers, and one and all have no one to blame but themselves.

It is to this problem of human sustenance that the science of conservation dedicates its most ardent attention.

If the present heedless exploitation could be effectively checked at this stage in our nation's progress, the problem of new millions evicted from the soil would at least grow no greater.

If, in addition to checking waste and exploitation, the practice of restoration of depleted areas could become a national habit, a gradual lessening of our nomad derelicts would be visible within a few years.

But, if we neither apply restoration nor check the exploitation of our natural resources, the human problem will continue to mount until society breaks down under the load, just as it has broken down throughout the long history of the old world.

Deserts have taken the lands which once sustained the hordes of human beings who built the Egyptian pyramids. Arabia and Persia, once the symbols of earthly splendor, are now the ragtag and bobtail of civilization. China has more people within her borders than she can feed on her worn-out lands. So have Japan, Italy, Spain, and Germany.

In America we are trying to fit together a picture puzzle map with 500 million acres missing. On that map we must fit a population which has increased 150 per cent in the last century. Small wonder we can not make it work. Conservation claims to know where to find most of the lost pieces and to make them again available.

The scientific principles of conservation and restoration are known, and technical demonstrations have proved their practicability. Except in size of operation, it is no more difficult to restore areas suitable to human living than it was to undertake the rehabilitation of the wild ducks and migratory waterfowl. In a brief period of five years the wild duck population has been more than doubled and the chief mechanism for that miracle has been the simple expedient of restoring the environment re-

quired by wild fowl in order that they might live a normal existence.

Those functions of nature which are necessary for ducks are, in a measure, little different from the functions which are required by man. Water, soil, and vegetation, when thrown out of balance, cease to function. Restore that balance and all nature again thrives.

General dismay over the impossibility of breaking the habits of the older generation has driven conservationists to the conclusion that the only hope lies in the education of the youngsters of the oncoming years who will inherit this continent and live such lives as the residue of natural resources will permit.

Perhaps by integrating the principles of applied conservation with the existing study courses of the public schools, some future American population may learn that water, soil, and vegetation are favored children of Mother Nature's organism and that to those who abuse them she metes out terrible and certain punishment.

To that end organized conservation has dedicated itself, and, as a contribution of material for such a high purpose, this book is heartily welcomed.

THIS IS OUR LAND

CHAPTER ONE

Land with a Promise

ONCE THERE was a country of fabulous riches. Magic forests of green covered its mountain slopes and grass of green gold carpeted the plains between. Silver water trickled down valleys, past hills that covered stores of mineral treasures, the like of which had never before been seen. The whole country was undisturbed and peaceful.

People in far-off countries, hearing tales of the place, called it the Promised Land. Explorers and voyagers who gazed with wonder at the riches and splendor of the new country called the land America.

Into this richest land in the world came a troubled and hungry people, honest and hard-working. They helped themselves freely to the wealth. Others came crowding into the land of promise, their eyes aglow with the hope of finding homes. And homes they did find, but this new people reveled in its green forests, scattered the mineral treasures, and flung to the winds the green gold of the plains.

By and by a wise man in the new land foresaw danger. He warned his people to guard its riches, or the country would become poor. This is our land, said the wise man; to preserve it we must practice conservation.

And this is the story of how the word conservation, still a baby among words, came into being. Actually it is a simple word, in spite of its history of three centuries. The language parents of the word "conservation" are of Latin origin. It is derived from *con,* meaning with or together, and *servare,* to keep, save, or protect. The whole meaning, therefore, is to keep together or to guard, and so to use wisely. It is applied to the husbanding of a country's resources, or wealth. These resources are of two kinds—natural and human.

Natural resources are the gifts of nature—soil, water, forests, grasses, wildlife, and minerals. They are the raw materials out

Great forests covered its mountain slopes.

of which all usable wealth is made. They are the riches which have led bold men to explore far-distant countries.

The human resource is the supply of man power—men, women, and children. Man power is the energy ready to change natural resources into wealth which you and I can use. A country has a supply of both present and future man power. The energy of grown men and women ready for immediate use is present man power. The energy of boys and girls, not yet ready for use, is future man power.

Conservation is the plan by which resources, both natural and human, may be best used. Wealth may be used in three ways. It may be saved through very scant use, and so be of scant benefit to anyone. It may be squandered or overused, and be of great

benefit to one generation alone, but to no other. Or, it may be wisely used to provide a good living for people of the present as well as the future. Conservation is certainly the last of these plans. Conservation means the wise use of wealth to allow this generation and every succeeding one a good living.

Resources are like the golden eggs which the fairy-story goose used to lay. Hoard them, kill the goose, or gather and sell the fresh eggs daily. Your hoarded eggs should rather have been used. Your roast goose would have tasted good, but suddenly you would find that new eggs were no longer being laid. But, if you fed the goose well, and each day gathered the egg, you would discover that a magic goose can be very useful, and can continue her usefulness.

Conservation is both a way of thinking and a way of living. The miser who starves himself so that he can hoard up a fortune untouched thinks and lives in one way. He thinks there is virtue in being stingy. After he has died, he gets no lasting thanks for his trouble. The spendthrift thinks and lives in quite another way. He squanders the last grains of his wealth, and, locust-fashion, must come shivering to his neighbors for aid. He believes that wealth is free for the using. He does not think of tomorrow, or of a people ahead who must find a way to live. After his death, the spendthrift is sure to be blamed for the way he lived and spent his fortune.

The conservationist is neither miser nor spendthrift, and is as far different from one as from the other. He thinks not only of himself, but of others who are his friends. He plans how much wealth is to be used and how much is to be left to provide for those who follow him. He knows that wealth and resources which are properly managed will furnish a good living for every generation to come. History will never forget the conservationist.

To accomplish its work, conservation draws information and equipment from science. Study of soils, rocks, water, trees, grasses, birds, animals, fish, and minerals adds to the tools that conservation must use. These subjects are known as agronomy, geology, hydrology, forestry, biology, and mineralogy. Knowledge of human resources comes from the study of human beings and their ways of thinking and acting. These studies are known as physiology, psychology, and sociology. Science discovers valu-

able practices for keeping wealth in best order; conservation puts these practices into effect.

Conservation is a way of treating the natural and human resources. Soil, water, forests, grasses, wildlife, minerals, and men must not be considered slaves to be mistreated for the miser's greed or the spendthrift's pleasure. Each is a friendly neighbor to be admired for the services it performs. Several of them give food. Some offer shelter and warmth. Still another gives us tools, and the last offers to help work. Each one is ready to make our leisure hours pleasant and profitable. Each resource ought to be treated with a respect and care born of deep appreciation. The conservationist knows the freshness of rich, dark soil and clear, swift-running water, the strength of sturdy forests and deep grasses, the excitement of finding shy wildlife and hidden minerals, and the dignity and power of human energy.

Balance in Nature

Natural resources by themselves exist in a friendly neighborhood of help-one-another. In a neighborhood where natural resources are untouched, each one helps the others to keep alive and healthy. How they depend on one another is indeed complex. Let us look at the peaceful co-operation of resources, and see how each one gives and receives.

The soil is really mother of them all. It feeds the forest and furnishes a foothold for the roots of trees. In payment, they enrich and guard the soil and keep it from blowing or washing away. Soil feeds the grasses as well. In payment, it is clothed with a cover of matted roots and thick leaves that resist the weather. Wildlife gets the food and shelter which forests and grasslands offer. In return, birds and animals enrich the soil. Minerals are protected from weathering by soil and earth, and in return add fertility to the soil. Through it all, water makes the soil more useful and available to the roots of growing things. The soil is a mighty reservoir for future use.

Water performs a unique service in sustaining the forests, grasses, and wildlife. Trees draw in a vast amount of water which is given off through the leaves. Both trees and grasses help water penetrate the soil to a place where it may be stored.

In a land at peace, resources live together in a friendly neighborhood of help-one-another.

Water gives a home to fish, and makes possible all life upon the earth.

Forests have important duties in the neighborhood. They work with grass to keep the soil fertile, loose, and capable of absorbing air and water. Water follows the roots of trees and thus helps to keep open the pores in the soil. The trees catch the wind in their branches, thus preventing too rapid evaporation of water, blowing of the soil, and destruction of grassy covers. In return, the grasses bind soil closely over the tree roots. Wildlife is furnished protection and food.

Grasses ask a living from the soil and water. For payment, they halt the rapid flow of water and keep the soil from disappearing as dust and silt. Grasses give shelter to the small forms of wildlife.

Wildlife asks little, but gives what it can to upbuild the other resources. At the death of animals and birds, the minerals of their bodies are added to the soil. Birds help in freeing the forests of insects. The beaver conserves water behind his small dams.

Minerals alone have little business with the other natural resources; but even they show some relationship. Forests, grasses, and wildlife add their minerals to the soil when they die. Flow-

ing water may concentrate the minerals into richer stores, or they may be taken up into growing things again.

Some persons have called the intricate pattern by which natural resources aid one another a balance. They say that, when man does not interfere, nature is in perfect balance. But that is hardly a true comparison. Even when left to themselves, natural resources have frequent squabbles. The growth rings of old trees with their marked differences in size from year to year, and the petrified forests of several states mark a few of the times and places that nature has been badly out of balance.

Although usually on the best of terms, natural resources have from time to time been turned from good neighbors into bad ones. A troublemaker has come which, beginning with one misdeed, has set off a whole chain of misdeeds spreading disaster. For example, even in a land untouched by man, lightning may strike a tree. If the forest is dry, it may burn from one side to another. Grasses are burned to the roots. Wildlife is killed and its homes destroyed. The soil, protected by neither trees nor grass, is washed down the hillsides and into the valleys. The supply of water shrinks.

Peaceful nature is sometimes upset by causes that can not be discovered. Dry weather used to disturb the land long before man's arrival. Scientists have a variety of explanations for dry weather. Some believe that spots on the sun in some manner determine how much rain is to fall. Regardless of the cause, there have been periods when trees and grasses have died for lack of water. The reservoir of water in the soil has run low, and streams have ceased to flow. Wildlife may have died from lack of food or water.

Often the changes which naturally occur among the resources have been thought to come at regular intervals. These changes have been called cycles. There is reason to believe that in some cases, rather regular cycles do exist. Years of dry and wet weather are indicated by the rings shown in a cross section of a tree, as they are narrow in dry seasons and wider in wet ones. If the wet and dry years recur at nearly regular periods, they are called cycles. Whether the excess or lack of moisture is caused by sunspots or not, the amount of moisture present during any year does have a corresponding influence on tree growth.

Cycles have been noticed among wildlife. Rabbits sometimes continue to increase in numbers until they overrun forests and fields. Diseases or animals then attack them, reducing them to only a small fraction of the former number. Gradually they increase and the cycle is repeated. Deer have been known to increase to such numbers that they have eaten off all the new forest growth. Lack of food and an increase in wolves bring the deer population back to normal.

But, despite cycles of wet and dry weather and other changes which take place naturally, the earth with its resources is almost always in fine adjustment. During the countless ages before white men settled, America had built up immensely fertile soil, large supplies of pure water, tremendous reaches of forests and grasses, a wealth of wildlife, and great stores of minerals. At almost any time you might have looked, the country would have been in complete adjustment.

The Balance Is Disturbed

America might have gone on peacefully had it not been for man. But, when he came and stirred up trouble, the whole land objected and all the real problems of conservation began. Natural resources had learned the art of getting along together after thousands of years of practice. But man knew nothing of how to live with resources, and cared even less.

He might have learned to live in harmony with the resources. He could have taken food from the soil for centuries as the grass and forests had been doing, if he had guarded the soil from washing and blowing. He could have drawn water for all time for drinking, for growing crops, and for power, if he had taken time to study the needs of water. He could have lived in harmony with the forests and could have been supplied with a continuous wealth of lumber, had he given them in return the care and attention which they required. He might have taken the gifts of grasses for all times, had he taken care not to destroy the roots by overgrazing. Wildlife might have given him food and recreation, had he repaid the birds, animals, and fish with only a little care. Forests might have tented the soil and cooled the countryside with their moisture.

But early Americans had not learned the lesson of living with nature. They were determined to live at its expense.

"Killing the sod makes the country humid," they said. "Trees are weeds which we must fight with axe and fire." "Draining swamps and killing wildlife give us greater room for making a living." The beliefs of early Americans, part of them right but most of them wrong, led to serious results.

When resources are improperly handled, each mistake becomes a sort of snowball that gains in size as it rolls downhill.

In a land disturbed by man or natural troublemakers resources become ferocious enemies which battle one another. Here good timber is being smothered by wind-blown sand.

When beavers were trapped almost to extinction in parts of Canada and the swamps and marshes drained, fires began to burn forests. The peat in low places began burning and made the soil unfit for growing forests. Geese and ducks left the country. The water supply continued to shrink. Much time and effort will be required to restore natural conditions. Canadian conservationists have begun the job by live-trapping and transplanting beavers to regions where they have become scarce.

In like manner, cutting the forests in America was the beginning of disaster. Water began to hurry to the ocean, carrying with it soil from the slopes. Soil began to muddy the streams, making them unfit for fish. Stream bottoms began to fill with silt, and the shallow water became too warm for game fish to live in. Streams had less room to flow, and often flooded over their banks. Floods brought down more and more silt and built the stream bottoms even higher. More and more often, rivers left their banks and spread ruin to croplands and cities. Each flood became more destructive than the last. Hurrying water found less time to seep into the soil, and the reservoir has been running low. Trees and grasses die and leave the soil even more exposed. Water speeds downhill. The soil dries, loses its network of roots, and is blown into the air. Dust chokes the people. Wildlife dies. And so the damage spreads over cities and countryside, destroying the human resource in places, and making life more difficult in others. The job of stopping misuse of the natural resources is one which requires great effort and immediate effort, before it becomes too large to accomplish.

In fitting himself into the pattern of natural resources, it was necessary that man make changes here and there. A large population could not live without clearing off a part of the trees, cultivating some of the land, and killing a part of the larger game animals. But man must learn how he can fit himself into the neighborhood of resources, and live in peace and harmony. He must study how he can add to the value of each resource. He must discover how to avoid the revenge which nature works upon countries which do not consider their resources. Fitting men into nature is the subject matter of conservation.

Two facts are evident in looking at the relation of resources to one another and to the human resource. When aid is given one, every other is helped. Planting even a single tree gives aid to the soil, to water, to grasses, to wildlife, to minerals, and, most important, to man. Seeding a slope to grass gives aid to the soil, to water, to wildlife, to minerals, and to man. It is hardly possible to perform only one service in conservation.

On the other hand, when a single unwise act is performed, harm may involve all the resources. A campfire left burning may affect the soil, water, forests, grasses, wildlife, minerals,

and again most important—man. Pasturing a steep slope can not but harm every other resource.

Nature's punishment for misuse of the earth is as certain and as great as the rewards she bestows for wise use.

When Americans began to take notice of the nation's mistakes, a few decided that resources ought to be placed under lock and key and used sparingly or not at all. The forests, they said, ought to be placed in reserves where they can not be cut. The minerals should be hoarded for future use. From a nation of spendthrifts we were changing to a nation of misers. Overuse changed into underuse or even no use.

Regaining the Balance

In the early 1900's, a new idea began taking form. Guided by such men as Gifford Pinchot and Theodore Roosevelt, the thought grew that resources could be wisely managed to provide materials for the present as well as the future. Pinchot chose the word *conservation* to describe the new idea. He realized that conservation must deal with every phase of natural wealth. Through his teaching and the work of scores of others, the nation stirred and is now beginning to awaken to the conservation movement.

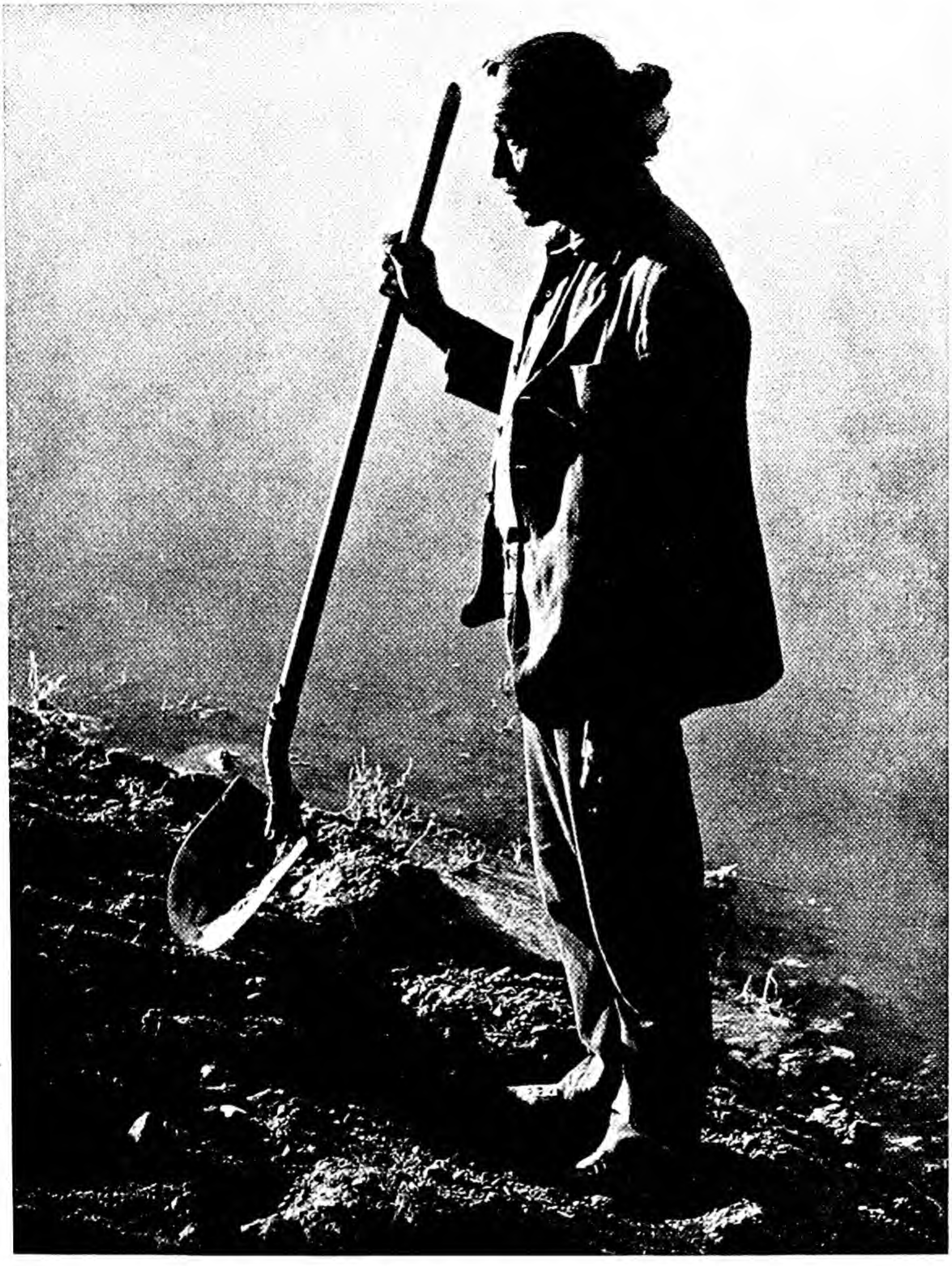
The awakening has been slow. Perhaps in some cases it has been too late. Whether or not there is still chance for recovery will depend upon how long the unwise use has continued. The age of a resource will give the answer.

The Resource Cycle

The history of how a resource has been used is much like the tale of a human life. The story begins with birth and continues during a gradual growth and development in use until there follows a slow decline, and finally death.

The cycle begins with the discovery of a material which has a use. It may be cut and shaped into houses, be made to turn wheels, or be served as food. Discovery of the value of a resource may be called its period of exploration.

As more persons learn the value of a resource, its use increases. Soon a great call arises for timber to build houses, for coal to furnish power, and for wildlife to satisfy appetites. New uses are found which make each resource more and more desir-



How to fit himself into nature has ever been man's problem in conservation, a fact which the Indian knew well.

able. The forest, it is found, will yield valuable materials for clothing. Coal will produce dyes and chemicals. Wildlife will give

From exploration to exhaustion is often a matter of only a few years.

recreation to hunters. To satisfy the great mounting demand for a resource, more effective means for its utilization are discovered. The greater call and better means of answering the call gradually

increase use of the resource until production reaches a peak. The resource is being used to its very limit. This is the "grown-up" period in its lifetime. The time of widespread use of a resource may be called its period of exploitation.

Finally, there comes a time in the life of a resource when its supply runs low. The forest dwindles. Coal becomes hard to find. The passenger pigeon disappears, and wild ducks become scarce. Before long, even the stray remnants are gone. In the lifetime of a resource, this stage is its old age and death. When the last of its value has been destroyed either by use or misuse, a resource has passed into what is called its period of exhaustion.

In the history of a resource, then, are periods of exploration, exploitation, and exhaustion. The benefits which are offered the human resource follow much the same pattern. Man can not profit from a resource until he has learned how to use it. When he has learned its use, he can live comfortably. He can ride in automobiles and live in warm houses heated by coal and gas and wood. But in the period of exhaustion, man must suffer. When forests are gone, he must look somewhere else for building material. Theodore Roosevelt once said, "When the soil is gone, men must go, and the process does not take long."

More than fifty million acres of land have already been washed away by erosion and twice that number is nearing ruin. Good soil is becoming scarcer. Soil once shovel-deep has been torn down from a great many hillsides. Soil has probably started downward on the path to exhaustion.

Water has been unwisely tapped from the great reservoir of the earth's storage. Springs have dried up and streams have ceased to flow. Floods are growing more numerous and more destructive. At the same time, the power in water has been developed only to a slight extent. In its use for power, the water resource is still in the period of discovery. In its use for crops, the water resource is passing into a decline.

Only about three in twenty acres remain of the magnificent forests that once stretched across much of America. The production of lumber has fallen considerably. In the Pacific Northwest alone remain the original forests, and they are falling before the axe and saw. Forests have most certainly passed their peak and are dropping downwards toward exhaustion.

To restore a devastated forest requires painstaking labor and great expense. Scene shows a planting crew at work on a logged-off and severely burned hillside.

Of the great reaches of once rich grasslands, only one fourth has been left unharmed. A large part of our grasses has been grazed to death. More than half the grass resource has been completely destroyed.

Wildlife has fallen lowest. Several species have passed into exhaustion or extinction. The fur trade has shrunk to a bare reminder of its former glory. Many valuable fish have all but died out completely. Many kinds of wildlife are only a few paces from complete exhaustion.

Minerals have grown old before their time. In the last 30 years, men have used more oil and coal, iron and copper than in all our previous history. More than a billion tons of iron have been produced in the United States. Some minerals are still in the period of discovery or exploration, many like iron and copper are at the peak of their period of exploitation; a great many like silver and lead are rapidly nearing exhaustion.

Most American resources show the results of spendthrift use and of great exploitation. Few are still producing at their top flow. Most of them are falling into the decline which, unchecked, must lead eventually to exhaustion. President Franklin D. Roosevelt marveled at how long our resources have held out. "A nation less bountifully endowed than ours," he said, "would have ceased to exist a long time ago."

If the path of every resource were to lead without question to exhaustion, then conservation would be a gloomy subject. But it is in the power of every man and woman to change the history of a resource away from decline and death.

Natural resources need not go to exhaustion, even though history shows that direction to be the usual one. The human resource can, therefore, live on.

Renewable and Nonrenewable Resources

The hope for changing the course of resources from the road of probable exhaustion to that of continued use lies in the difference between two words—renewable and nonrenewable. The soil, water, forest, grass, wildlife, and human resources are all renewable. Each one may be restored again to strength, revived, replaced, or made new. If the process of decline has not gone too far, a renewable resource may be brought back to its period of youth, and made to continue to supply valuable products indefinitely. Renewable is an exciting word, full of hope for those who are planning a wealth for the future.

Only minerals are nonrenewable. Once they are mined, they are forever gone from the earth. No more can be produced to replace them, and no amount of careful use can restore them. In the chapter on minerals, their particular place in conservation will be discussed.

Dividing all resources into the two great classes, renewable and nonrenewable, according to whether or not they can be restored, also separates conservation practices into two general types. Renewable resources must be so cared for that they will yield products and benefits for all time. Nonrenewable resources must be cared for to put off as long as possible the time when they will become exhausted. The difference is simply one of

The practice of re-use gives hope to the conservationist. Here are piles of railroad scrap and farm machine scrap to be resmelted for re-use.

time—keeping one productive for all time, and the other for as long a time as possible.

The Methods of Conservation

In general, the aims of conserving resources must be toward these four principles—wise use, re-use, best use, and planned use.

Wise use of a resource requires careful study to make it produce at its peak. Forests are cut and replanted and protected from fire. The human resource is put to work and cared for so that it may be kept healthy and strong.

Re-use is possible with most resources. Particularly with metals, re-use is important in prolonging the day of exhaustion. Once it has been used, copper can be collected and re-used. Water can be used for irrigation, for power, and for navigation. Re-use may also be called multiple use.

Best use of a resource means that it is put to the most important of its uses. Fertile soil on a steep slope is perhaps not at its best use in pasture. It would be more profitably used for crops.

Iron is not at its best use in a place where concrete or stone will serve.

Planned use requires that resources be managed on a system which looks into the future. Men must compute how much soil will be needed to grow crops that will keep pace with an increasing population. Planning a thoughtful program should prevent the grave errors of the past. Trained experts might have discovered in time that most of the swamp and marshland drained twenty years ago was unnecessary for farming.

Several means have been put into effect to carry out the aims of conservation. Restriction, production, and management have all been tried.

Restriction was the natural answer to men who watched the country's resources fall before unwise cropping, ditching, lumbering, grazing, shooting, and mining which was without control or regulation. Particularly with wildlife, laws were passed which restricted the season of shooting and fishing, the catch, and the size. Before long a great body of laws had been set up, all designed to limit or prevent the use of wildlife. But the most carefully designed laws did not preserve the passenger pigeon or the heath hen. Laws alone, men learned to their sorrow, can never bring back dead and dying resources.

A new idea grew. The renewable resources should be raised artificially, in game and fish hatcheries, and in forest nursery plots. So artificial production came to be used as a means of conservation. But weaknesses in this method were soon clear. Although replanting a small plot of forest or grassland might be successful, very often a large tract could not be profitably replanted. The cost of reforesting idle acres is great.

At present, a third means is being used for making wise use of resources, and for promoting their re-use, best use, and planned use. Management is really production by the use of nature's own methods. Colleges and universities are training young men and women in game management, forest management, range management, and in the problems of water, soil, and mineral conservation.

In management, care is taken of the resources where they are found. Rather than replant and restore forests, grasses, and wildlife to a region, each is encouraged by improving the condi-

tions in nature which will cause the resource to return. Cattle and sheep are fenced out of forests which are in need of new growth. Grass is protected from burning to give game birds an easier chance to increase. Here and there small changes are made in nature which aid the resources to become adjusted. Soil may be replenished or renewed by adding fertilizers, but it can more cheaply be enriched by plowing under green crops. Dams may be built to halt floods, but water can be caught and held by a cover of forests and grass.

Behind all management of our resources there must be careful study and research. If fish are to be managed wisely, and made to increase in size and numbers, men must know what kind of waters are best suited to their growth. A fish manager must know the temperature of water at varying depths, the kind of food throughout the lake, the purity and amount of silt present, and many other facts. Making only a few changes in the surroundings might greatly increase the fish population. Restriction and artificial production will, of course, be employed as a part of management.

Good management is really a job of good housekeeping. For a happy, contented people, the earth must be made to produce food and a clean, healthful place to live. We must learn that protected soil and water are as necessary to a nation's health as are clean food and homes to a family's well-being.

One part of conservation has been widely debated. The National Resources Committee expresses the growing belief of the United States in stating: "The natural resources of America are the heritage of the whole nation and should be conserved and utilized for the benefit of all of our people." Just how our natural wealth is to be distributed to give the greatest good to the greatest number of people is a puzzling problem. Some believe that government control would be the fairest answer. Others are equally certain that each person must exercise his own regulation. Whatever the solution may be, one truth is clear—no man or small body of men can be allowed to misuse any resource for his own profit and thus deprive other men of a fair share. No man has the right to pollute a stream or lake, to slaughter game and fish, or to waste precious metals and fuels. A country's resources are the gift of nature to an entire people.

They do not belong to this generation, to the last nor to the next. No single man or generation can ever earn the right to use them wastefully.

Man power is the most important of all resources. Each natural resource depends for its value upon its usefulness to mankind. Soil is valuable because it helps to feed, clothe, and shelter mankind. Water is precious for the wheels it turns, the boats it carries, the fields it waters, and the drink it gives to men. Grass takes on importance because of the pasture it furnishes cattle and sheep, and these are used only by mankind. Wildlife is guarded and protected because of the food and furs with which it provides mankind. The tools, the heat, and the power men get from minerals give that resource its value. The more useful any resource may be to the human resource the more carefully it should be preserved.

But natural resources are useful to man for another, almost equally important reason. Besides providing him with a living, they add to his happiness. They fill his leisure hours as well as his working hours with something to do. More and more, men are learning the untold value of natural resources in giving opportunity for recreation. P. S. Lovejoy, a well-known conservationist, describes a fine change taking place in man's appreciation of natural wealth:

> In the past [men's pleasure from the outdoors] has usually meant hunting or fishing facilities, but in the modern and wider sense includes the aesthetic as well; the chance to see a deer as well as the chance to shoot one; the chance to photograph a beaver lodge as well as to wear a fur collar; the chance to observe arbutus peeping through the snow-packed leaves as well as to buy bunches of the naked flowers from a car window; the chance to wander down aisles carpeted with soft, brown pine needles and to listen to the sighing of the zephyrs in the boughs as well as [the chance] to buy lumber.

A country kept in good order is a pleasant one in which to work and play. Land that provides a good living will also provide a happy living. When forests are green, when wildlife is plentiful, when water is pure, and soil is covered with deep grass, then men can live abundant and happy lives.

A ghost town is the graveyard which marks the place of dead resources.

The Sustained Yield

To protect the living and happiness of the human resource, natural resources with the exception of minerals, must be so managed that they will continue to remain useful for all time. This is the principle of the sustained yield. It is the most important single thought in conservation.

When a resource is said to be on a sustained yield basis, it means that that resource is producing at a rate which will allow it to continue the same yield. No more is taken each year than is grown or replaced during the year. Soil on a sustained yield remains as rich and productive as it was when first cropped, because green crops are plowed under, and fertilizers added. A farmer and his family may live on their soil without fear that its fertility will die. In parts of Europe, the soil has been farmed for more than a thousand years with little loss in productivity. When water is managed on a sustained yield, the great reservoir in the earth will keep always constant. Streams and rivers will flow throughout the summer, wells will furnish a steady source of drinking water, and water wheels will yield continuous power. No more water will be drawn off in any year than falls and is absorbed into the ground.

When forests are planned to produce on a sustained yield, only the same amount of lumber can be taken each year as is

A managed town can be kept alive forever on a permanent income based upon a sustained yield.

grown on the entire area. The yield each year is like the interest which an amount of capital earns. In the case of forests, sometimes the yield is harvested every five, ten, or even more years, since trees are slow-growing.

Grasses on a sustained yield will provide grazing for cattle on the same pastures without change. Ranchers and their families can build homes because their source of wealth is unending. Towns and cities which depend upon grasses and ranching will remain prosperous and stable.

When wildlife is managed on a sustained yield, only an amount of game and fish equal to the year's crop will be taken. There will always be an ample number left to insure the next season's crop. There will be no need for fishing or hunting all day without luck.

In America there is proof that men have been ignorant of the idea behind the sustained yield. Ghost towns are all that remain of thriving cities and villages which lived, locust-fashion, on some natural resource until its wealth was completely spent. The stores and schools and homes are deserted. Haunted and forlorn they look now, with the windows gone and the walls sagging from decay. They are the tombstones of dead resources. Families may have lived in the town, never knowing that their near-by

wealth would play out. But the day finally came when their forests or grasses, water, soil, or minerals were gone.

In a managed town, the people draw from a resource which they manage on a sustained yield. If it depends on minerals it may be kept alive a long time if the supply is wisely preserved.

Conservation a Current Problem

What are the characteristics of a study of conservation?

Conservation is a study of nowness. What must be done, must be done now—before it is too late. A farmer sighed as he looked at his barren hillsides. "If only I could have known about conservation sooner," he said, "while the rich soil still clung to the slopes."

Conservation is a study of immediacy. Your course in government fits you to become a wise, voting citizen. But what you learn in conservation you can begin to practice today as successfully and with as good results as when you are grown. Conservation is as much a work for Boy Scouts, Girl Scouts, Campfire Girls, 4-H clubs, and Future Farmers as it is of the National Resources Committee.

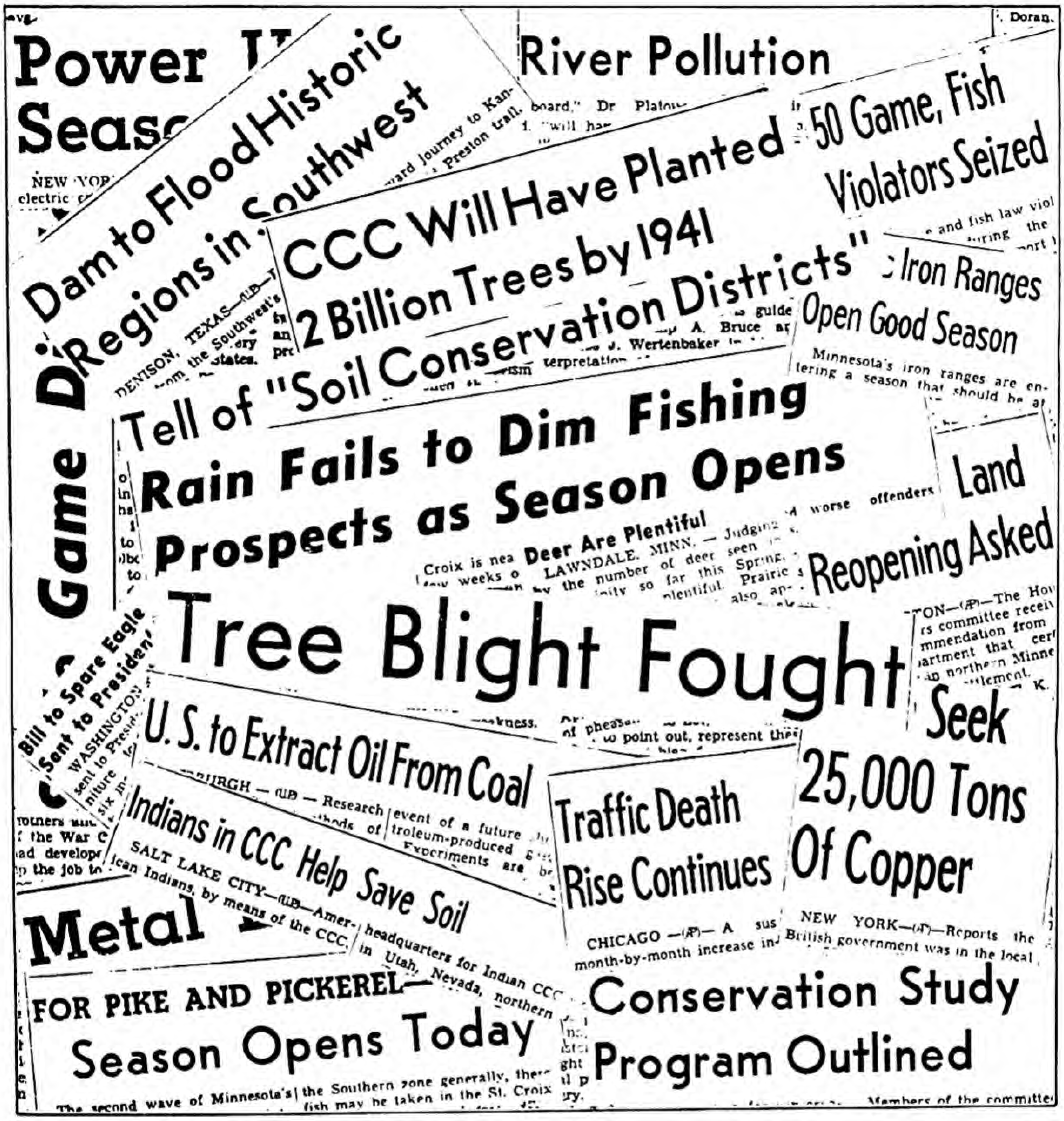
Everywhere about us, the ideas of conservation are being discussed. In newspapers and magazines, over the radio and in public meetings, there is frequent mention of conservation. Stories of floods, dust storms, drouth, and scores of other calamities are daily reminders of the need for action.

Conservation is a daily and a current problem. Its problems and solutions are alive and growing. The study is one of thoughtfulness. Not even a book can point out to you exactly what you can perform in stopping waste. All the while you read, you must be thinking about the evils in your own community and how they may be remedied. Together with the teacher, a class can discover many jobs which must be done.

Conservation is not a learn, but a learn-and-do study. The facts you learn are those which will help you plan and carry out programs of wise use in your neighborhood.

The ideas underlying our government are the ideas underlying conservation. The problems of the nation are those which the people themselves can discuss and remedy. This is the basic idea of democracy.

Conservation is not alone a study of big problems. Many of the problems involved are little ones, but they are urgent. It is



Conservation is a study of current problems.

not alone the work of engineers and foresters, but of every person who turns these pages. Your job is to play fair with all outdoors.

Whenever you see muddy water flowing, you know that the job of conservation is still undone. When you find that one quart in every gallon of the Ohio River at low stage has passed through a sewage system, and the river goes on, largely untreated, to

give drinking water to 2,500,000 people, then you will know that the job of conservation is a desperately necessary one.

If you live in the upper Mississippi Valley, your work of stopping soil losses and of planting the slopes to trees and grasses is already outlined. Unless you who live along the lower Mississippi practice conservation and preach it from the headwaters to the gulf, your homes and lands are in danger of floods. You who live in the Great Plains—your job in conservation is immediate. You must keep the soil from blowing and the supply of water constant.

To you who live in the Pacific Northwest, the problem of putting your forests on a sustained yield is one which will determine the future of your towns and cities and their families. You who live in the great Southwest must guard your grasses, your water, and your still abundant metals and fuels. If you live in the South, you must watch the soil and keep it on the fields. You in the East have a job to do to keep your man power healthy and productive.

There is work to do in conservation wherever in the United States you may live.

Perhaps some of you may choose to continue study and research to attack more advanced problems of conservation. A few of you may, for example, set about to discover new uses for our great stores of titanium and tungsten. There will be need in the future for trained conservationists.

If our country and its people begin at once the job of conservation, our children's children will have cause to thank us. They will be proud to say "This is our land."

REVIEW QUESTIONS

1. Of what does any country's wealth consist?
2. How did the word "conservation" come into being?
3. What two kinds of wealth does a country possess? Describe each.
4. How can conservation be both a way of thinking and a way of living?
5. How does the conservationist regard natural resources?
6. Explain how each natural resource gives and takes in a land in harmony. How should man take part?
7. How do cycles sometimes occur in a land undisturbed by man?

8. Name several ways in which man has thrown the natural resources out of adjustment.
9. Why are some resources renewable and others nonrenewable?
10. In the life history of a resource, what are the three chief periods?
11. What becomes of any resource which is misused?
12. To which of these—overuse, underuse, wise use—have resources been subjected?
13. In which period of its history is each of the resources?
14. Name the principles guiding the use of any resources. Give examples.
15. Conservation has thus far been a study of three lines of work. Name them and show where each may be used.
16. Explain in detail what is meant by the term "sustained yield."
17. What tragic story does every ghost town tell?
18. Why should every town study its sources of income?
19. Name the characteristics of the study of conservation. Describe each.

SUGGESTED ACTIVITIES

1. In reference books, study the early history of conservation.
2. Study your community and its sources of income. Which of them will probably be important forty years from now?
3. Plan charts, folders, or posters to represent the miser, the spendthrift, and the conservationist.
4. Report on the conservation work of one European country.
5. Gather figures on the amount of any resource which has been used in the last hundred years. Chart them on a graph. What might they illustrate as regards the history of the resource?
6. Find in your community a resource which has been wisely used for a great many years. Describe to the class the plan of its use.
7. In a scrapbook keep magazine and newspaper clippings of conservation reports in which you are interested. Report to the class any items of particular importance.
8. Begin now to write for additional information on each of the resources. File the pamphlets, books, and data you get for future classes. Individuals or committees can work on special problems.
9. Arrange for special speakers to address the class during the school year. Keep a list of the questions that arise which you should like to have answered.
10. By writing early for films and slides you will be able to make your work even more interesting. Many of the government agencies have pictures available without charge.
11. Organize a conservation club. Give it a name. Plan awards for the best accomplishments in conservation.

Debate: Resolved, That conservation today is three times as important as it will be twenty years from now.

CHAPTER TWO

Opening Up America

ALMOST from the beginning of time, ownership of land has been a symbol of independence and a mark of nobility. It was ownership of land throughout Europe that differentiated the free man from the serf, the lord from the vassal, and that conferred nobility on a man and his long line of descendants. The yearning for possession of land has ever been an incentive to colonization. In the case of America, "free land" was an expression that enticed the despairing peasants of class-bound Europe, and its power drew thousands to our shores.

It is true that some immigrated because their religious beliefs were not tolerated at home, and they could not worship according to the old formula; but this group constituted a very small part of those who came. Others came seeking gold and silver; some to trap; and some for pure adventure. After the main stream of immigration had started, it was good land and free land, not religion, nor furs, not gold and silver, that brought streaming tides of eager Europeans to America. The thousands who came in the 1600's, the hundreds of thousands in the 1700's, and the more than twenty millions who came in the 1800's, were all seeking land.

The European sovereigns had granted generous charters for land extending far to the west. It was easy to be generous with something they regarded as having slight value. Land in America was apparently unlimited in extent. There was little incentive to conserve it. Why save it? It was free. Men thought then, as they think now, that anything free is worthless. Consequently, the pioneers thought very little about conservation.

What settlers did not have and needed most was open land for their crops. On the Atlantic Coast there was no open country as there was in the West. Everywhere there was forest, and trees were the greatest obstacle to farming.

Since there was no market for the timber, it had to be de-

stroyed. Ships were too few and too small to carry logs. No person in New England would buy them when his own back yard was full. The big problem was how best to destroy the trees. The "log rolling bee" was one means. A man could cut down massive trees, working alone, but they were far too heavy for him to move. Neighbors, therefore, came to help roll the logs together and burn them in great bonfires. Log rolling bees became social events of the time.

Indians and forests blocked early development of America. The forests were without defense, but the Indians fought back. Here a band of Comanches is shown attacking a wagon train.

Besides the forests, Indians were another great hindrance to settlement. At first the Indians were friendly and helpful, but, eventually, dismayed by the never-ending stream of settlers and by injustices done them, they became hostile. As long as the Indians lived in the forest, they were almost unbeatable. Once the forest was cleared away, they could easily be beaten off. Thus the Indians were still another reason for destroying the forests. The real struggle, however, was between the settlers and the forests. The settlers were forced to chop out cropland from the forest or starve.

These were the determining objectives and hindrances at work in the development of America. They have had a lasting influence on the philosophy of the American people. They have

created a philosophy of waste. With these thoughts firmly in mind, let us watch the struggles and progress of those who made of the wilderness a nation.

Beginning in 1607, plucky little ships—not much larger than our present-day oyster boats—came nosing out of the mists of the stormy Atlantic and landed their small but eager bands of colonists on the eastern shore. There the settlers stood on a narrow strip of beach gazing wonderingly at an unbroken forest; alone on a great continent with only the food they had in the chests beside them, and no open land for growing any more food.

And, so, through the next hundred and fifty years other colonists settled in Virginia, New York, Massachusetts, New Hampshire, Maryland, Connecticut, Rhode Island, North Carolina, New Jersey, South Carolina, Pennsylvania, Delaware, and Georgia. The Spaniards were already in Florida. Everywhere the conditions were much the same—nothing but unbroken forests inhabited by tribes of Indians, many of them fierce. Only the kinds of trees and Indian tribes differed. The main problems of existence and advancement were the same.

In New England the great white pines towered above the hardwood forest. The climate was severe, the topography hilly, and the soil fertile but held in the sturdy grasp of a mighty forest and burdened with a load of surface stone. More than a hundred years of hard labor were needed to clear away that forest and hundreds of miles of stone wall were built before the soil was clear enough for cultivation. Beyond this land lay mountains.

The colonists were as yet unappreciative of the water power rushing down streams, destined some day to turn the machinery of an industrial nation.

To the south, in the Middle Atlantic colonies of New York, Pennsylvania, New Jersey, Delaware, and Virginia, pioneers found living conditions less trying. The climate was milder, the ground less stony and more level; but forests and Indians were to be encountered here also. Here the people were so busy wresting a living from the forest and fighting with the proprietors of the colonies on the one side and the stubborn Indians on the other, that they were thankful for a small patch of land on which to live, and completely overlooked the treasures hidden in the ground around them. The iron and coal and oil in Pennsylvania

and Virginia and West Virginia meant nothing to them. Even had they found them, they could not have made use of these resources, for there were yet no coal stoves, no steam engines, and no smelters. The mountains to the west and the ever-present Indians hemmed them in completely.

Spaniards who sought Florida did so for gold and springs of eternal youth. The soil within their reach was sandy as the beach itself. Flat as a table top, this sandy coastal plain, covered with a dense growth of yellow pine timber, extended back inland from fifty to one hundred fifty miles, and from the eastern shore of Maryland to Texas. The timber was destined to be a valuable asset some day, but it offered no encouragement to the restless Spaniards. Finally, the remnant of these adventurers returned home without leaving any lasting impression on the country.

The settlements in the Carolinas and other southern colonies were more successful. Here, with the help of slave labor, great cotton and tobacco plantations were established in the rich river bottoms. The colonists traveled upstream along the river, avoiding the sand plains. The fertile clay lands of the Piedmont Plateau offered them temporary promise and reward.

The Appalachian Mountains are not high as mountains go, but they, nevertheless, halted the flow of westward migration. Narrow passes are barriers to ox carts. The country beyond the hills was occupied by Indians already hostile as a result of wrongs they had suffered. So, for more than a hundred years, settlers on the Atlantic Coast looked with curious wonder at that western barrier. Beyond, all was unknown except to a few adventurous men who had crossed the mountains and traversed the wilderness as far as the Mississippi River.

The fabulous stories these men brought back excited the people and filled them with an urge to cross the mountains into the rich country beyond. By the end of the eighteenth century the incentives became so great that a rising tide of settlers under the guidance of such men as Daniel Boone and Simon Kenton sought their fortunes over the mountains in the Ohio Valley.

There they found a richer soil but a heavier forest and no less determined Indians. It was in the Ohio Valley that the Indians made their greatest drive to destroy the white man once and for all. Tecumseh and his brother, the Prophet, founded a

miles. At present those thirteen states contain only about 326,000 square miles. In 1779 an agreement was made between these states and the Government whereby most land between the Appalachian Mountains and the Mississippi River was ceded to the new Government that was just beginning to function. The colonies, many of them deeply in debt, exchanged their land grants west of the mountains in return for the Federal Government's action in taking over their debts.

So began the vast "public domain," as the unappropriated lands belonging to the Federal Government came to be called.

Out of this original public land, known as the Ohio Country, were later carved the states of Kentucky, West Virginia, Illinois, Tennessee, Mississippi, Alabama, Ohio, Indiana, Michigan, Wisconsin and part of Minnesota. It was a vast, rolling country of rich soil, free from mountains and covered with the best hardwood forest in the whole United States. There was, indeed, some open country, but the larger part was heavily timbered. In addition to its timber and soil well suited to agriculture, much of the section was later found to be rich in coal deposits. It had oil under much of it and considerable deposits of copper and iron in many sections.

The next large addition to the country came in 1803 when President Thomas Jefferson took advantage of a bargain land offer by France, the chance to buy 828,000 square miles of territory at a total cost of $27,000,000, or a little more than five cents an acre. This addition almost doubled the area of the United States. From this tract, known as the Louisiana Purchase, were created the states of Arkansas, Oklahoma, Kansas, Missouri, Nebraska, Iowa, North Dakota, South Dakota, Montana, most of Minnesota, parts of Colorado and Wyoming, and Louisiana, except a small part in the southeast corner that belonged to Spain. Louisiana, Missouri, and Arkansas were timbered, but the rest, for the most part, was open. There were millions of acres of prairie land ready for the plow, and grazing lands ready to support millions of cattle. There was also abundant lead and zinc in Missouri and some of the more western states, copper in Montana, gold in South Dakota, Colorado and Nevada, coal in a number of the states, and in Oklahoma, one of the richest oil fields in the country.

To subdue the Indians and prepare for the settlers who were to follow, guides and troops went into the area of the Louisiana Purchase. The Custer expedition of 1874 is shown here encamped near Hidden Wood Creek in what is now South Dakota.

In 1819, Spain despairing of finding either gold or eternal youth in Florida, offered to cede that territory and a small tract farther west to the United States if we would assume the war claims charged against it. The area amounted to about 72,000 square miles and the claims were $5,000,000. Although there was no direct charge for the land, it cost more than twice as much per acre as the Louisiana Purchase. It was, nevertheless, another good bargain.

The riches of the plains in soil fertility and wildlife are well indicated in a letter written from Fort Mandan in what is now North Dakota to his mother by Captain Meriwether Lewis

on March 31, 1805, on the outward journey of the Lewis and Clark Expedition of that year. Captain Lewis wrote in part:

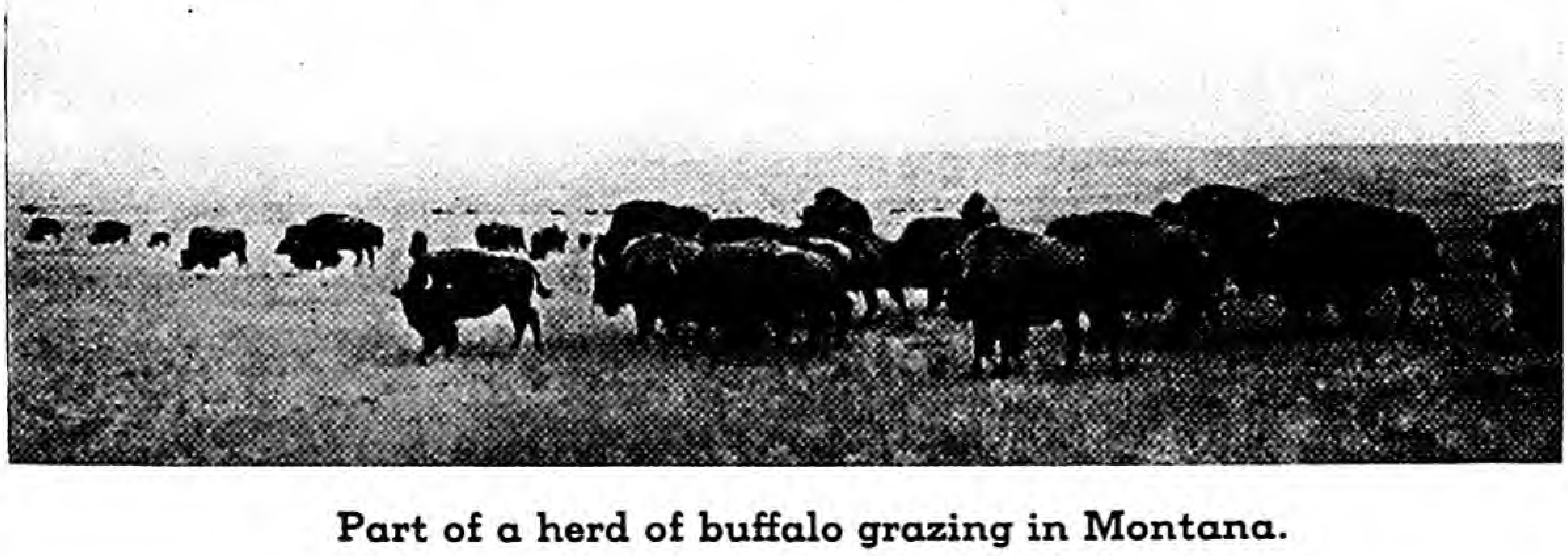
Captain Meriwether Lewis of the famous Lewis and Clark expedition of 1805 looks over the broad Montana grasslands that were later to support great herds of cattle and sheep.

This immence river so far as we have yet ascended waters one of the fairest portions of the globe, nor do I believe that there is in the universe a similar extent of country, equally fertile, well watered, and intersected by such a number of navigable streams. The country as high up this river as the Mouth of the river Platte, a distance of 630 miles is generally well timbered; at some little distance above this river the open or prairie country commences. with rispect this open country I have been agreeably disappointed, from previous information I had been led to believe, that it was barren, steril and sandy; but on the contrary I found it fertile in the extreem, the soil being from one to 20 feet in debth, consisting of a fine black loam, intermixed with a sufficient quantity of sand only to induce a luxuriant growth of grass and other vegitable productions, particularly such as are not liable to be much injured, or wholy distroyed by the ravages of the fire. it is also generally level yet well watered; in short there can exist no other objection to it except that of the want of timber, which is truly a very serious one. This want of timber is by no means attributable to a deficiency in the soil to produced it, but ows it's origine to the ravages of the fires, which the natives kindle in these plains at all seasons of the year. the country on both sides of the river, except some of it's bottom lands, for an immence distance is one continued open plain, in which no timber is to be seen, except a few detached and scattered copse, and clumps of trees, which from their moist

situations, or the steep declivities of hills ar sheltered from the effects of fire. the general aspect of the country is level so far as the perception of the spectator will enable him to determine, but from the rapidity of the Missoury, it must be considerable elevated as it passes to the N. West; it is broken only on the borders of the watercourses.

Game is very abundant, and seems to increase as we progress; our prospect for starving is therefore consequently small. on the lower portion of the Missouri, from it's junction with the Mississippi, to the entrance of the Osage river, we met with some deer, bear, and turkies; from thence to the Kancez river, the deer were more abundant, a great number of black bear, some turkies, geese, swan and ducks; from thence to the mouth of the great river Platte, an immence quantity of deer, some bear, Elk, turkies, geese, swan and ducks from thence to the river S . . ., some deer, a great number of Elk, the bear disappeared almost entirely, some turkies, geese swan and ducks; from thence to the mouth of white river, vast herds of Buffalos, Elk, and some deer and a greater quantity of turkies than we had before seen; a circumstance which I did not much expect, in a country so distitute of timber. from hence to Fort mandan, the Buffalos, Elk and deer increase in quantity, with the addition of the Cabre as they are usually called by the French engages, but which is abot the size of a small deer.

In 1846 a dispute arose between Great Britain and the United States over a tract in the northwest known as the Oregon Territory. The United States based its claims on the grounds of discovery and occupation, and on the Louisiana Purchase. Great Britain claimed that it had been explored by Vancouver and occupied by British fur traders. Settlers flocked into the country and for a while it seemed that the countries would come to blows. A treaty was finally concluded which added to the United States the territory that was later to become Washington, Oregon, Idaho, and parts of Montana and Wyoming, and adding British



Part of a herd of buffalo grazing in Montana.

Columbia and other territory to Canada. This territory included 286,000 square miles and contained much rough country in the Rocky, Cascade, and Coast Range mountains, but on the western slopes grew the heaviest coniferous forests in the world, and in the interior lay a valley that has since been irrigated to become the world's greatest apple orchard.

The annexation of Texas to the Union in 1845 added another vast territory of 389,000 square miles, from which were created, besides Texas, parts of New Mexico, Oklahoma, and Colorado. The cession brought on the war with Mexico in 1848. Out of the Mexican cession and the Gadsden purchase that followed, the nation acquired another 558,000 square miles at a cost of about eight cents an acre. From this tract were carved California, Nevada, Utah, Arizona, New Mexico, and parts of Colorado and Wyoming.

Only a small corner of Texas was timbered, but it still included as much timberland as most states. Texas also added great grazing ground and tremendously rich oil and gas fields. The state is developing into a leading producer of citrus fruit. The other states contained gold, silver, copper, and other valuable minerals. California and Oklahoma contributed also great stores of oil and gas.

So ends the story of how we have gathered about us the lands that now form the United States. Now let us note how these lands were distributed.

Disposal of Public Lands

At the time of the Louisiana Purchase, the United States had a population of less than six million people and an area of one and one half million square miles. Men had been too busy making a living to think much of building roads over the mountains, through the forests, and across the plains. Distances were greater than the settlers had known in the European countries. There were as yet no railroads. There was much for the infant Government to do, but very little money with which to work. The few people scattered about the country could not possibly produce the necessary taxes. The answer was clear that there must be more people.

Just how was America to get these needed citizens? It had but one thing to offer—land. Land it had in abundance, and the young nation began to give it out with a lavish hand. Men were quick to estimate the Government's attitude and to take advantage of it. Careless practices of distributing land soon became corrupt practices, and the record of how the public lands were parceled out is not a matter of which we may be proud. Cheating the Government of its land became common practice, but the Government did not become disturbed.

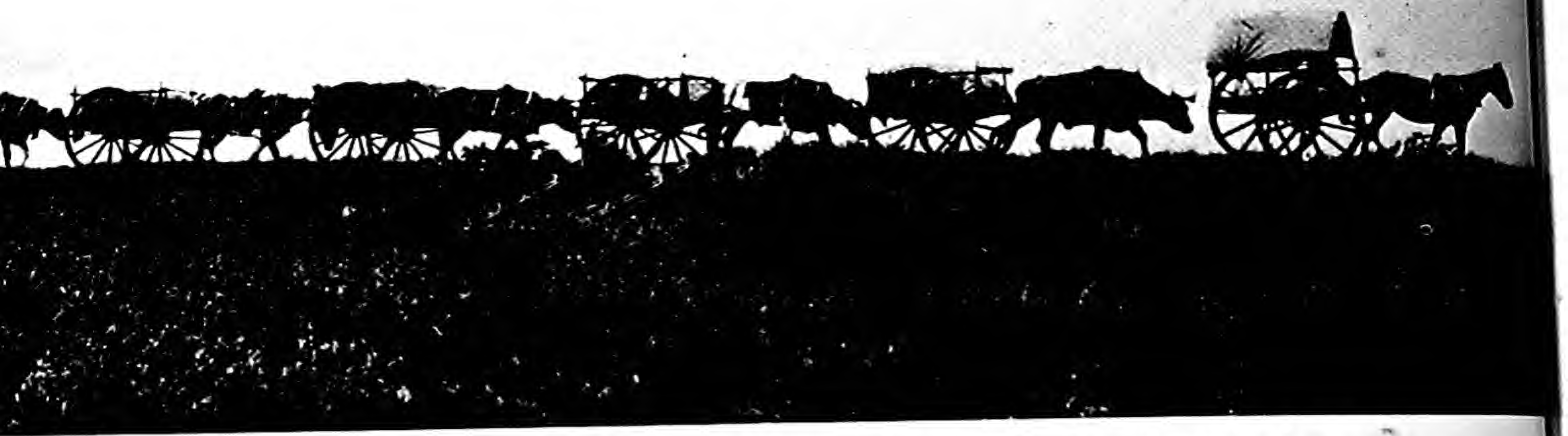
At first, land was sold outright for about a dollar or two an acre and the receipts were used to run the hard-pressed Government. But even at that price, sales were much too slow. Immigration began to increase by leaps and bounds and there had to be a quicker way of getting people settled on the tax rolls.

The Homestead Act was passed in 1862 to speed up settlement. Any citizen, the head of a family and of legal age, or anyone who had declared his intention to become a citizen could file a homestead claim on an unappropriated 160-acre tract. By living on it for a time and making certain improvements, he secured title to it without paying for it. Thus it was possible for every citizen to become owner of a 160-acre farm. Many got title to other homesteads without either living on them or making the required improvements.

Almost a steady train of covered wagons wound its way out to the prairies. The land office was such a busy place that the phrase "doing a land office business" came to be synonymous with great activity. In about 40 years all the good land was taken. But the land hunger of the people and the tax hunger of the Government were not yet satisfied. Settlers moved into the dry plains. One might think that every man would have found all the land he wanted by that time, but, later still, some land in Indian reservations was opened to settlement and people rushed there to obtain claims.

Still eager to push forward settlement of the nation, the Government from time to time advertised that on a set date new areas would be opened to settlement.

Men and women came on horseback and in light buckboards. Some hired race horses. Settling on the land was a race, with the best locations on the tract for prizes. No one was allowed to



Almost a steady stream of covered wagons moved over the prairies. Ox carts carried settlers and supplies into the Northwest.

enter before the appointed time. Would-be settlers lined up eagerly along the edge of the tract. Some came days ahead and camped on the line. Often they fought for the best points until soldiers were called to keep peace. When the moment arrived and the restraining rope was cut, the whole line of men and women broke forward and the ground fairly shook under the thunder of hoofs and the crashing of clumsy wagons that rushed over the rough prairie sod. Nothing of this kind had been seen since buffalo stampeded over the plains.

Nor did the race end when settlers staked their claims. There were fights to decide who was first comer and rivalry to build houses and be the first to make smoke rise from the chimney. They cut and rolled up strips of turf to make sod houses, or dug root cellars for shelter until they could get lumber or logs to build homes. Tradesmen of all kinds, too, raced with their wares to build stores or put up their shop in tents and in two days they were established and selling merchandise at outrageous prices. Many made fortunes in a few mad days. Towns of a thousand inhabitants sprang up where there had been only prairie sod ten days before.

The American people were indeed quick to take advantage of this great distribution of public lands!

But still larger gifts of land were to be made. The act providing for 160-acre homesteads was satisfactory except that it did not make provisions for good and poor soils. In some regions, 160 acres was not enough land to be farmed successfully; in others it was more than could be properly handled. So Congress passed the Timber and Stone Act which gave every homesteader 320 acres of the poorer lands that were valuable for grazing and

timber. When the semi-arid desert regions were reached, the Desert Land Act made possible 640-acre tracts.

All these Acts aimed to distribute farm lands. The lumbermen have been accused, and in many cases justly so, of obtaining land by all kinds of dishonest practices. They bought 40-acre tracts and logged the surrounding sections. They employed professional homesteaders to take up many claims. When no one objected, they logged off whole townships.

One might get the idea that lumbermen were alone responsible for the land frauds. But they were not. Everyone was lax in dealing with the Government; stealing Government land was hardly regarded as a wrong. The lumberman operated on a larger scale merely because his industry needed larger tracts, and there were no means for him, as a logger, to secure these tracts. As we have seen, every land Act looked to the farmer, and no provision was made for the logger. Not until the present timber sale policy of the Forest Service was adopted in 1907 did the Government make adequate provision for allowing the logger to obtain timber from public lands.

Another great part of the public lands went to encourage transportation. With a population too sparse to build roads, the railroad was almost a necessity if the country was to be settled

A growing population needed lumber for mining timbers and for railroad ties. Forests began to fall under the mastery of axe and saw. Logs were floated down rivers or were hauled out over iced roads to the sawmills. Here is a load of 250 tons leaving a Minnesota forest.

Two stages in the laying of the railroads across the Northwest in the 1880's. Above, building the roadbed. Below, laying the rails on the ties. Material trains brought the rails, ties, and other supplies to within a half mile of the rail head, where teams took the ties ahead and iron cars, drawn by horses, moved the rails to the end of the track.

quickly. Land was the only gift that the country could offer the railroads but it gave land generously.

Land grants to railroads usually took the form of every other section of land for a specified distance on either side of the tracks. Some of the grants extended out as far as thirty miles and were the equivalent of small empires. It was intended that this land should be used to develop freight along the lines. In a number of cases the companies accepted the grants but never built the tracks. Railroads still hold a considerable quantity of land.

Education, too, needed encouragement. It must be remembered that the United States was the first of the modern democracies. The fathers of the country wisely realized that a democracy could be successful only if all its citizens were educated. They, therefore, launched upon a policy of public education such as the world had never before known.

Building schools in the vast, sparsely populated states of the West was extremely difficult. Again the Federal Government turned to its endless lands to encourage development. The Morrill Act granted to some of the states sections 16 and 36 of every township of Federal lands within their boundaries not already given over to some other purpose. Some states sold their lands at once for very little. The few that kept them now have a fine endowment.

Many states contained large areas of swampland. Actually, with the good land already in production, there was no need to put the swamps to work. But the Federal Government, in its haste to develop new taxpayers, passed a Swamp Land Act which gave swampland to the states with the understanding that it be drained and sold. The states were pleased with the bargain; but some of them cheated by forgetting to drain the land as they promised, and by selecting good highland timberland instead of swamp.

These have been the principal measures for distributing the public lands. About two fifths of them were sold; slightly more than one fourth was transferred to private hands through the Homestead laws; a little less than one tenth was granted to railroads, and 23 per cent was given for aid to education, for canal, road and river improvements, and as swampland.

America had accomplished what it had tried so hard to do—

settle the country from coast to coast and make it a power in the world.

Other great tracts of land were withdrawn from the public domain to form national forests, national parks, Indian reservations, wild life refuges, national monuments and military reservations.

The national forests make up the largest part of these withdrawals. They were intended to perform two very important functions: to act as timber reserves for the nation; and to protect watersheds for the regulation of stream flow. The national parks are not so extensive. They were created to preserve extraordinary features and scenic spots that might otherwise be exploited or destroyed by commercial developments. The Indian reservations were established as refuges where the long-harassed Indians could live without interference from white men. A few reservations have been opened to white settlement when a decrease in Indian population made them appear no longer necessary or when Government policy changed. That part of our public domain still in the hands of the Government has little present value except for grazing. Occasionally new mineral values are found.

In the first frantic rush for land, minerals other than gold were largely overlooked. It was not until the end of the nineteenth century that the rich iron mines of Minnesota and Alabama were discovered. Many minerals, of course, had comparatively little value at the time.

Iron was in comparatively slight demand until the development of the railroads. Oil wells were not particularly important until the extensive use of gas engines. When minerals were at length discovered, they were found in such lavish abundance that men thought little of squandering them just as they had despoiled the forests and depleted the soil.

Waste Follows Plenty

In the story of how America was settled, it is unfair to criticize early settlers too harshly for what appear today to have been gross mistakes. All about lay wealth which at the time seemed inexhaustible. None but the most cautious could have imagined that in a few short years the stretches of forest and

Early trappers opened the greatest treasure house of furs the world had ever seen. One of the most common methods of travel and transportation was by dog sled.

grassland and rich soil would become precious, and wildlife shrink to a bare fraction of its natural population.

It is not hard, therefore, to account for their actions. The saying that "abundance breeds waste" is a true one. Besides, the pioneers felt that they had a job to do. They had to open America, they thought, and make it a glorious nation in the eyes of Europe. A mighty forest blocked their way to the soil. They slashed it down and burned it, put the plow to the soil, and gained the wherewithal to live. They turned over the prairie sod and exposed a soil of immense fertility. Indians and lack of roads blocked them from getting furs, their best cash crop. They picked their way through the wilderness, traded with the Indians, then beat them back and opened the greatest treasure house of furs that the world had seen.

What did it matter if they had destroyed the forest? There was plenty elsewhere, they believed. What if continuous cotton, tobacco, and wheat cropping did wear out land and send rich topsoil washing into rivers and whirling away with the wind? There would always be plenty of land to crop, they said. What if the fur bearers should be trapped almost to extinction? Furs were no longer necessary for their existence. This was no time to

worry over the future, when right now wealth lay before them ready for the first man to claim. These false notions made up the doctrine which guided most of our early history.

Waste in earlier days was more or less to be pardoned, even though it was unfortunate. But the greatest calamity has been this—that the false notions of plenty have bred in the American people a doctrine of waste that has persisted down to the present day, long after excuse for misusing our wealth is gone. All along the way, the methods by which the public lands and their resources were gathered together and later distributed have fixed the idea that natural wealth was to be used without thought of the future and of generations to follow. Waste has become our national philosophy, and it is one that only years of re-education can possibly revise. But change that philosophy we must if our nation is not to take its place beside Samarkand, Persia, Mesopotamia, and other once-glorious countries that have squandered their natural wealth and sunk into an obscurity of blowing sands and deserts.

The early pioneers can be pardoned for their misdeeds. They had not been shown the history of waste. But the generations that take our places can hardly pardon us if we continue blindly to follow the path of destruction that yearly destroys 25 million acres of good farm land; that every year is clogging our streams and lakes with filth; that is shrinking the forests so generously provided by nature to only a fraction of their former size, and that is all but ruining our grasslands. If we allow our ducks and geese and other wildfowl, our fur bearers and game animals to die out completely, as many species seem doomed to, we can not face the future without knowledge of the shameful waste we have permitted. Our children will certainly blame us when they ask what has become of the pike and bass and crappies that still abound in our neighboring lakes, or of the vast mineral stores that today are still too often being squandered.

Conservation of these resources is a study for vigorous men and women. It is work that every boy and girl can do who has the will to serve his country wisely.

In the chapters that follow we shall look more closely into the problems of conserving each natural resource. As the story of waste is not a pleasant one, we shall look into the past only

long enough to learn how to avoid making the mistakes of the past generation. Our end and aim shall be to find how everyone may begin the battle against the unwise use of natural wealth. We shall read why and how every American must guard, preserve, and conserve America, its soil, its waters, its forests, its grasslands, its wildlife, its minerals and its people. This will be the burden of the following chapters.

REVIEW QUESTIONS

1. Why was free land a great attraction to European immigrants?
2. What two great obstacles hindered development of this free land? How were they removed?
3. For what reasons did America build a philosophy of waste?
4. Along the Atlantic Coast, what resources did the colonists find? Which did they overlook?
5. What kinds of soil were in each section?
6. Describe the resources which explorers found to the west of the Appalachians.
7. After land had been made available, what new resources came into demand?
8. What is the public domain?
9. From what source did the first public domain come? Describe the resources of the first grant.
10. What were several later additions to the public domain?
11. Why were officials in a hurry to dispose of the public lands?
12. What attractions were offered early settlers? Describe the several methods for disposing of lands.
13. Why did lumbermen resort to questionable practices?
14. What aid was given railroads? Why?
15. What provisions were made for schools?
16. What are the chief uses that the Government has made of the public domain?
17. Which resource was at first all but forgotten?
18. What was the attitude of settlers toward the forest? How did the history of the settlement of America help shape this attitude?
19. Why can there be no excuse for present-day waste?
20. Where are there still public lands to be distributed?

SUGGESTED ACTIVITIES

1. Report on the conservation practices of early colonizers and statesmen. Among them might be Penn, Washington, Jefferson, and Franklin.

2. Find the complete story of the Lewis and Clark expedition. Contrast the land as they found it with the same territory as it appears today. Look for other early expeditions.
3. Make a study of what has been done with the school lands in your community.
4. Locate and name the chief uses of the public lands by the Government. Which may be used for recreation, forests, grazing?
5. Map the original resources. On your map indicate the principal streams of settlers.
6. Chart the growth of the public domain, showing the year of accessions, cost, area, and resources of each addition.
7. Outline the chief means for disposing of the public domain. Give the number of acres distributed through each means.
8. Preserve some historical feature of your community and mark it clearly.

Debate: Resolved, That waste was necessary in opening up America.

Soil is the mother of earth and men. Well managed, it provides abundantly. Poorly managed, it is soon lost, and with its loss goes our source of food, shelter, and clothing.

CHAPTER THREE

Soil Conservation

THE MOST valuable natural resource is soil. Over the giant, rocky framework of the earth it spreads out in a thin layer, giving life and strength to the plants which feed upon it. In places, soil may be only a few inches deep, and in others it may extend down for many feet, but almost everywhere it is present, and has been generously mothering mankind for thousands of years.

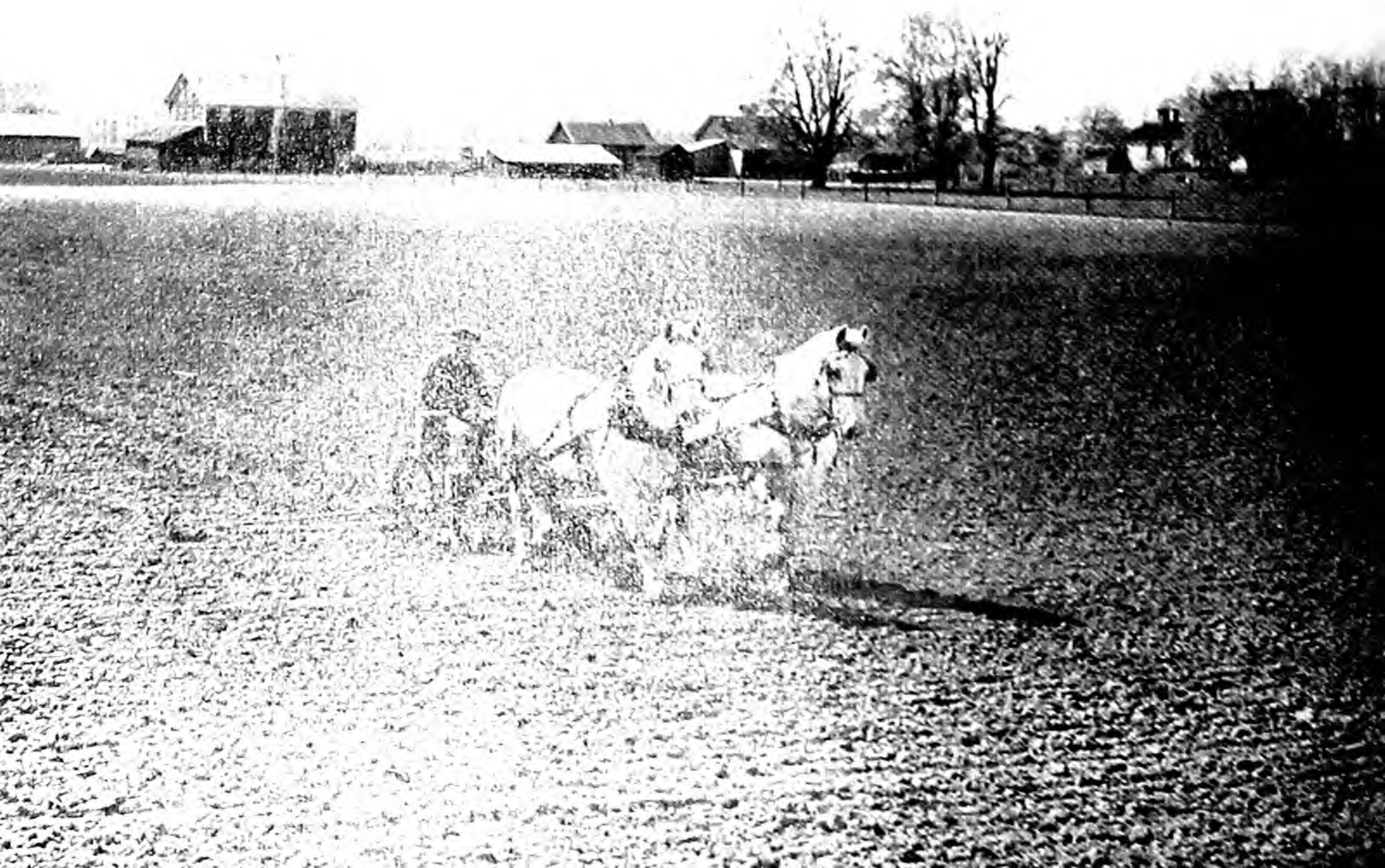
Only lately, however, have many people taken notice of this generosity of the soil. Even fewer have been aroused to regard it as anything but a permanent good. A few of the leaders in colonial times had observed that their soil was washing away, but little was done. George Washington used soil-conserving practices at Mount Vernon. Thomas Jefferson seeded grasses on eroded land and practiced horizontal or contour plowing. Patrick Henry stated that "since the achievement of our independence, he is the greatest patriot, who stops the most gullies."

But not until 130 years later did the United States awaken to realize that soil is not as free as air, nor as rugged as rock, nor capable of holding up under the onslaught of years of unwise grazing, cropping, and timber-cutting. When storms of dust began to choke the Middle West, when floods swept over the fields of fertile valleys burying them deep with gravel and silt, and when whole hillsides and croplands and homes slid into swift-moving rivers, then Americans first started to realize that soil was something that could not be held under lock and key. It has taken a series of catastrophes to teach the American public the value of the soil and the urgent need for keeping it on the fields and under the grasslands and forests where it belongs.

As a result, there is growing up in this country the conviction that soil is a national heritage. As such, it should be safeguarded by the Government. A good citizen regards himself not as an absolute owner of the soil but rather as a manager set in

It has taken the catastrophes of dust storms and floods to teach the need for soil conservation. Near Los Angeles flood waters rose above the river banks, leaving homes and farms in ruins. In Oregon high winds sweeping across a dry lake bed left summer cottages almost buried.

A good soil manager is a good citizen. He so maintains the soil that it yields abundantly.



charge of using it wisely. His duty is one of passing on to succeeding managers a soil which is as good as, or better than, when he found it.

His task is not easy. The forces which scatter soil and destroy its value work quickly, sometimes at a furious speed. A few years of unwise cropping will allow a heavy rain to cut out deep gullies in a few hours' time. The forces which build soil and improve its fertility work slowly, painfully so. In the thousands or millions of years since the earth began, there has formed only a thin crust of true soil, generally measured in inches.

Formation of Soil

The story of how soil is formed and becomes enriched requires that a thousand years be crowded into every paragraph.

Let us start, for example, with lifeless, molten rock, such as that which has formed the basis of the soils throughout much of the high plains. The molten lava flowed in liquid form from the deep chambers of the earth through the crater of some ancient volcano, long since extinct and obscure. Spreading over a large surface, it cooled and hardened into a solid crust of rock. No coat of soil covered it yet. All that was visible was bare rock.

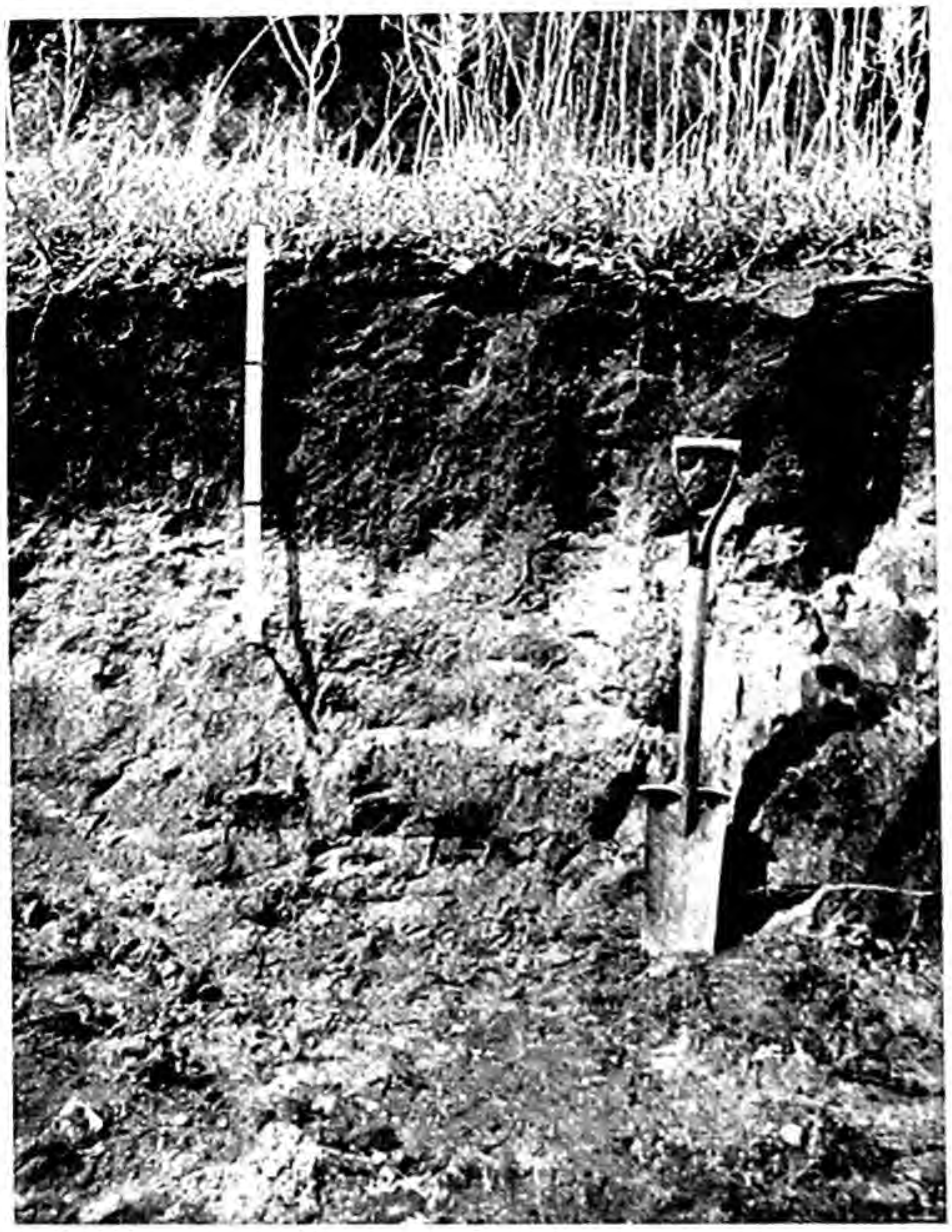
In the centuries that followed, rain, containing minute quantities of acid, beat upon the rock and dissolved small bits of it. Moisture soaked into the surface layer. Varying temperatures brought alternate freezing and thawing, with consequent expansion and contraction which split off slivers, exposing new surfaces to the dissolving power of the rains. Gradually the broken surface of the rock began to catch and hold slight amounts of rain.

The moist top rock made an attractive bed for the spores of some lichens which happened to be passing. They settled there and grew. They excreted small quantities of acid on the rock, hurrying the decomposition. Whenever the rock dried, the lichens stopped growing, but did not die.

With the dissolving of the rock, certain elements such as calcium, phosphorus, potassium, and magnesium, were set free. Some insects died, and their disintegration supplied nitrogen, another very necessary element.

The next step in the formation of soil was simple. Seeds of plants lodged in a crack filled with the essential foods, and grew.

When the plants died, they rotted and enriched the soil. Each succeeding generation of plants continued to make the soil deeper and more fertile. So, gradually, its depth and quality increased until it could support grasslands and forests. Some have estimated that it takes nature 500 years to form a single inch of soil.



Formation of soil is a painfully slow process. It takes 500 years for nature to build a single inch.

Each kind of rock makes a typical soil. Soil that is formed by the disintegration of lava is clay soil. Soil formed from sandstone is sandy soil. Where organic or living matter is added, the soil is called a loam, sandy loam or clay loam, depending upon whether sand or clay predominates.

Soil is not always related to the rock on which it rests, but some soils develop beside the rock from which they were formed. They are called residual soils.

Most soils have been transported and deposited in some new location. These are called transported soils. Water is the commonest means of carrying soil, and soils so carried are known as waterlaid soils. The soil of the Atlantic Coastal Plain was laid there by the ocean when that land was submerged below the surface. Much of the earth's surface that is now dry land was likewise below the ocean long ages ago. Streams rising in the mountains and hills transport soil to the level plains below.

Another important agency in transporting soil has been the

glacier. Many thousand years ago, ice sheets which were hundreds of feet thick crept down from the Arctic Circle and covered a large part of the northern United States. They moved very slowly, but their great weight and pressure planed the tops off mountains, gouged out valleys, blocked river channels and carried with them enormous quantities of rock and soil. As they melted back northward, they left behind a mixture of soils collected over great distances.

Composition

Soil supplies the plants with food. Contained within soil are the elements which determine how productive it shall be. They are phosphorus, calcium, nitrogen, sulphur, carbon, oxygen, hydrogen, potassium, magnesium, and iron. Lately it has been discovered that four other elements are required in small quantities or traces. These trace elements are manganese, copper, boron, and zinc. Plants take most generous helpings of phosphorus, calcium, potassium, and nitrogen. It is these elements which are most likely to become exhausted.

The United States is well supplied with these four elements. Phosphorus is found in the Southeast, in Florida, South Carolina, Tennessee, Arkansas, Kentucky, and in the Rocky Mountain states of Idaho, Montana, Wyoming, and Utah. It may not always be as easily obtained as now, but there is a supply which should last for a great many years, or until the cost of mining it becomes unduly high. This fact should be remembered about phosphorus: once it is leached out and carried into the larger streams, it is gone beyond recovery. By controlling this loss a farmer need not renew his fields as often as otherwise might be necessary.

Calcium is derived from limestone, of which there is a plentiful supply for liming soils now deficient.

Potassium exists in fairly large quantities in Texas, New Mexico, and Nebraska. This country is still, however, importing about one half of what is being used.

By means of electricity, nitrogen can be extracted from the air and fixed in the form of soluble nitrates which the plant can absorb. There need be no shortage of nitrogen in the soil, and yet too often there is. The quantity of nitrogen left is one of the best measures of a soil's fertility. Nitrogen is an essential element in

plant growth. Some of it is washed out of the atmosphere and brought down with the rain, but most of it comes from decomposing vegetable and animal matter. It can be increased by growing legumes—the clovers and alfalfa, soybeans and cowpeas—or by plowing under green, growing crops.

Steady cropping robbed this land of its nitrogen, phosphate, and potash. When these elements were returned to the soil at the right, the corn grew tall and healthy. Unfed, the corn at the left is weak and sickly.

In speaking of the deposits of fertilizers which are available it must be remembered that they are of no value until spread upon the soil where they are needed. This means that farms ought to be managed so as to retain the food elements as long as possible.

When soil is cropped year after year and nothing is added to maintain its fertility it will eventually become poor in plant foods. In other words it is said to be worn out. If fertility is to be constant, the elements upon which plants feed must be replaced.

But, besides the mineral elements, soil must have organic or vegetable matter to supply food for bacteria and to give proper texture to the soil. The texture or physical composition of the soil often has as much to do with fertility as the food elements

themselves. Soil must be loose, airy, and filled with partly decayed leaves, twigs, and grass. Such soil readily absorbs water and gives better air-holding capacity.

As vegetation dies, it is attacked by an army of fungi and bacteria which eventually breaks it down into the original plant foods. In the course of this process, the plant fibers form a thin mulch of protective covering over the surface of the soil. As it loses the original form, this mulch begins to mingle with the mineral soil and is known as "humus." The Soil Conservation Service says:

> The soil is far from being a solid mass. Its natural texture is more nearly like that of a bathroom sponge. A cubic foot of topsoil may contain as much as 60 per cent of air. Soils in virgin forests and grasslands are the most porous of all. If you dig into such soils you will find that they have loose, crumbly structures. You can almost work them with your bare hands. Such soils can absorb water almost as fast as you can supply it. They can absorb 12 to 15 or more inches of rain. The upper 3 inches of forest soils taken from old-growth stands of hardwoods in the Ohio Valley, for example, absorbed 14 times as much water a minute as the more compact adjacent field soils, and the upper inch 50 times as much.

Plant fiber can be added to the soil by spreading manure over the land. In addition, much of the plant food is returned that was taken from the land when the crop was harvested and removed. Burning the straw from fields destroys a great quantity of vegetable matter that would aerate and enrich the soil.

Penalties of Soil Depletion

Sometimes soil that is badly worn by long cropping is allowed to return to forests or grasslands for a generation. How does it happen that farm crops rob the fertility of soil, and that forests and grasses build fertility?

The difference is that most of the minerals which a crop draws from the soil go into the heads of the grain or into the fruits and are carried off the field; but the minerals appropriated by trees go very largely into the leaves and twigs. The minerals in grass are deposited each fall on the top layer of earth, adding a small part to the soil. Every year the leaves fall and the minerals are returned to the soil to be used again. Even when a

tree is cut, only the log, which contains but small quantities of minerals, is taken away. A ton log, when burned, will leave only a spoonful of mineral ash.

History is full of the records of nations which have risen to power and greatness, only to sink into obscurity when their soils have been destroyed. The Bible called Canaan a "land of milk and honey." Today the soil is all but exhausted from overwork. Erosion has stolen the soil fertility and made Canaan a semi-arid waste. Mark Antony on his way to see Cleopatra led his slow-moving legions from Palestine to Egypt with little difficulty. When the fast-moving British army crossed that same country during the World War of 1918, it was necessary to pipe water along with them. All about the ruins of a hundred dead cities of North Syria can be seen the bare hills where erosion has spread destruction over more than a million acres of land. When these cities were alive and the surrounding hillsides covered with red soil, a civilization flourished which might have taught the present world much about architecture and art.

Two hundred years ago, eastern China was a fertile land, supporting millions of inhabitants. Misuse of the soil and consequent erosion transformed the fertile plains into a veritable desert. Not only is the soil depleted, but it is completely gone. It is said one can travel up the Yangtze River for a thousand miles and see scarcely a green, living thing. Only where soil has been brought in or built up artificially can any crops be grown. For fuel the people collect dead grass.

Xenophon says that when Cyrus led his great army across Mesopotamia, the country was covered with forests and luxuriant vegetation. The armies lived on the fruit and abundant game. Today Mesopotamia is desolate and almost completely lifeless.

Samarkand was at one time a wealthy country, teeming with people. About the year 1200, one of her native sons, Genghis Khan, led forth a victorious army which conquered all the explored world from China to Hungary with the single exception of India. Two hundred years later, Tamerlane repeated the performance. His conquests included India but left out China, whither he was headed when he died. The great capital of Samarkand had a population of more than a million people when Paris and London were villages of from 4,000 to 6,000. But so busy

were they with fighting that the people did not learn to maintain their soil. And how many people today know of the once-glorious Samarkand?

America today is following the trail of the Chinese, and of the people of Canaan, Mesopotamia, and Samarkand. Every year we are robbing land of its elements and leaving the soil a little nearer starvation. The preservation of our soil fertility is one of the most sacred trusts of the American people. This trust has been betrayed partly by neglect and partly because of lack of information.

Destructive Forces

Early settlers found the East and South covered with an unbroken forest. To get land for their fields and homes, they cut and burned off most of the trees. When the rich, fresh lands of the West were discovered, settlers streamed over the prairies, bringing with them cattle and sheep to graze the grasslands.

When plows turned over the sod, they exposed some of the richest soil in the world. Black and fertile, it grew great crops of wheat, year after year. Gradually even this rich soil was robbed of its mineral elements and plant fiber. No thought was given to replacing them—no fertilizers, no manure or green crops plowed under, and no change of crop.

As the nation grew, it needed increasing millions of acres for agriculture, for grazing, and for logging in order to produce food and building materials for home use and for export. As a result, much of the native vegetation disappeared.

The final, crowning folly in the story of soil waste resulted from the war demands for food for the armies of the world. Not satisfied with increasing the crops on land suited for farming, men invaded the grazing lands of the western plains, where water was too scanty to support a continuous sod. The Government was as much to blame in favoring the movement. The world called for wheat. Wheat was an easy crop to grow, required little work, and often yielded a good profit. No thought was given to the soil. After the harvest, much fertility went up in the smoke of burning strawstacks.

The same plains that had once supported millions of buffalo would have continued to feed the great herds of cattle and sheep

with which they were stocked. They would likely have supported those herds indefinitely; but the grass was plowed under, while the warring nations still asked for wheat. For a few wet years, with the organic matter accumulated by thousands of years of grass, men prospered for a time while prices were soaring.

Then came the drouth. Crops grew smaller and smaller. The organic matter which had helped to hold the soil together was destroyed, and the ground was laid bare to the furious attacks of the unresting winds. They tore away at the surface soil and sent it flying.

Crops were blown out of the ground or often buried beneath several inches of soil. Herds of cattle starved to death. Dust in the air filled hospitals to capacity with pneumonia patients.

Floods grew more violent, and in 1937 the Mississippi, Allegheny, and Ohio Rivers flooded more than half a million homes and vast areas of farm lands. Deaths totaling 900 resulted.

The catastrophes of dust storms and floods have finally brought home to the American people the necessity of action—united action and immediate action. The soil was blowing away and washing away.

Erosion

The annual loss from erosion of all kinds has been estimated at $400,000,000. This is about 20 times the value taken out by crops! Some predict that, if erosion is not checked, 50 years from now much of our rich country will be as sterile as the once fertile sections of northeast China.

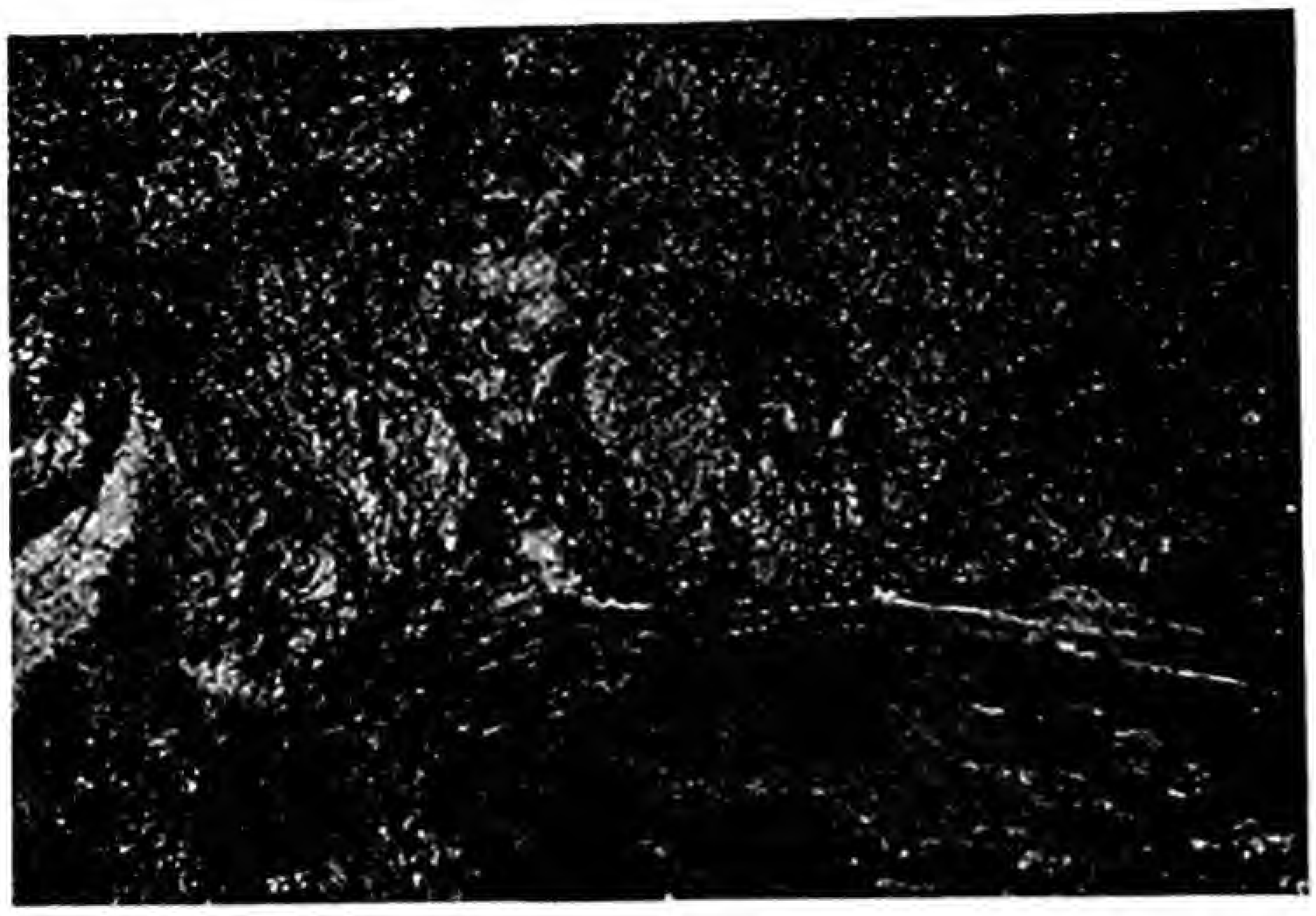
Fifty million acres once tilled in the United States have already been ruined by erosion. The National Resources Board has estimated that 4 million tons of nitrogen, 31 million tons of potash, 40 million tons of calcium, 12 million tons of magnesium, and 220 million tons of organic matter are being eroded away in this country every year. As if this were not damage enough, the same soil is dumped into streams where it kills fish, and in rivers where it hinders navigation.

Such is the story of the grave errors that have been permitted in the treatment of the most valuable of our natural resources. Let us now consider the forces which are destroyers of the soil and of its fertility.

Erosion does two kinds of damage: it carries soil away from where it is needed, leaving gaping ditches in once level, fertile, easily-farmed fields; it puts poor, infertile, sandy soil where it is unwanted, covering fields and fences. This gully will soon cut the field in two.

Sand and gravel have covered two fences, and a third row of posts has been erected within a year after the second.

Soil fertility and soil itself are removed in two, or possibly three, ways. Soil may be depleted by repeated croppings year after year, and it may be lost by erosion. Some describe a third type of soil loss — by leaching. These losses will be treated in the order of their importance.



Here is California bean land, worth $500 an acre, being torn away beyond recovery.

Fertility which leaches or drains away through the soil does so when the cover has been removed. The food elements are washed out by hard rains, carried down through the surface soils, and finally left out of reach of the roots. If this process continues long enough, a hardpan may form and the land be ruined unless reclaimed by the expensive addition of fertilizers. All this destruction may, in large measure, be prevented by the planting of proper crops. The crop roots catch the fugitive elements before they get out of reach, incorporate them in the plant and return them to the surface soil when the plants die. Thus they are kept near the surface.

Soil may also suffer through depletion. There is no necessity for land to wear out through cropping. Some fields in Europe have been cultivated continuously for more than a thousand years. They are still producing larger farm crops than our fields, many of which have been cropped for less than a hundred years. Heavy fertilizing and years of careful rebuilding will be needed to restore these soils. The damage might have been avoided by rotating the kinds of crops planted each year, and by applying a little fertilizer each year to replace the elements removed by the last crop.

By far the most destructive force is erosion. It may be thought of as a thief who breaks through the cover of grass, shrubs, crops, and trees. The word erosion, from the Latin

Water, uncontrolled, is a soil thief, tearing away the earth, carrying it down creeks and rivers where it is valueless.

erodere, literally means "to gnaw out"—and that is a very good description of its action.

There are two chief agents of erosion, wind and water. Wind and water together account for all the tremendous losses from erosion. They have been gnawing at the world for ages in what is known as geological erosion. The topography of our country with its hills, its plains, and its valleys, is the direct result of such erosion. Expansion and contraction from within the earth heaved the ground up in some places and depressed it in others, but erosion cut the surface pattern. Vast plateaus have been lowered hundreds of feet by erosion and reduced to a series of rounded hills and valleys.

No one objects to natural or geological erosion. The earth would probably be uninhabitable if erosion by wind and water had not prepared the way for us, smoothing mountains and depositing soil where it could be used. It is another kind of erosion which is of interest to us.

Harmful, man-made erosion begins where man attempts to rearrange nature in order that he may make it minister to his need. When these changes in nature are unwisely made, erosion starts to destroy the fields in which we grow our crops, and causes floods that wash away our homes.

Water uncontrolled is a soil thief which can not help but steal. It is the nature of water to dissolve everything soluble that it touches. When water can find a lower level it begins to run and carries away with it whatever it may have surrounded.

Gully Erosion

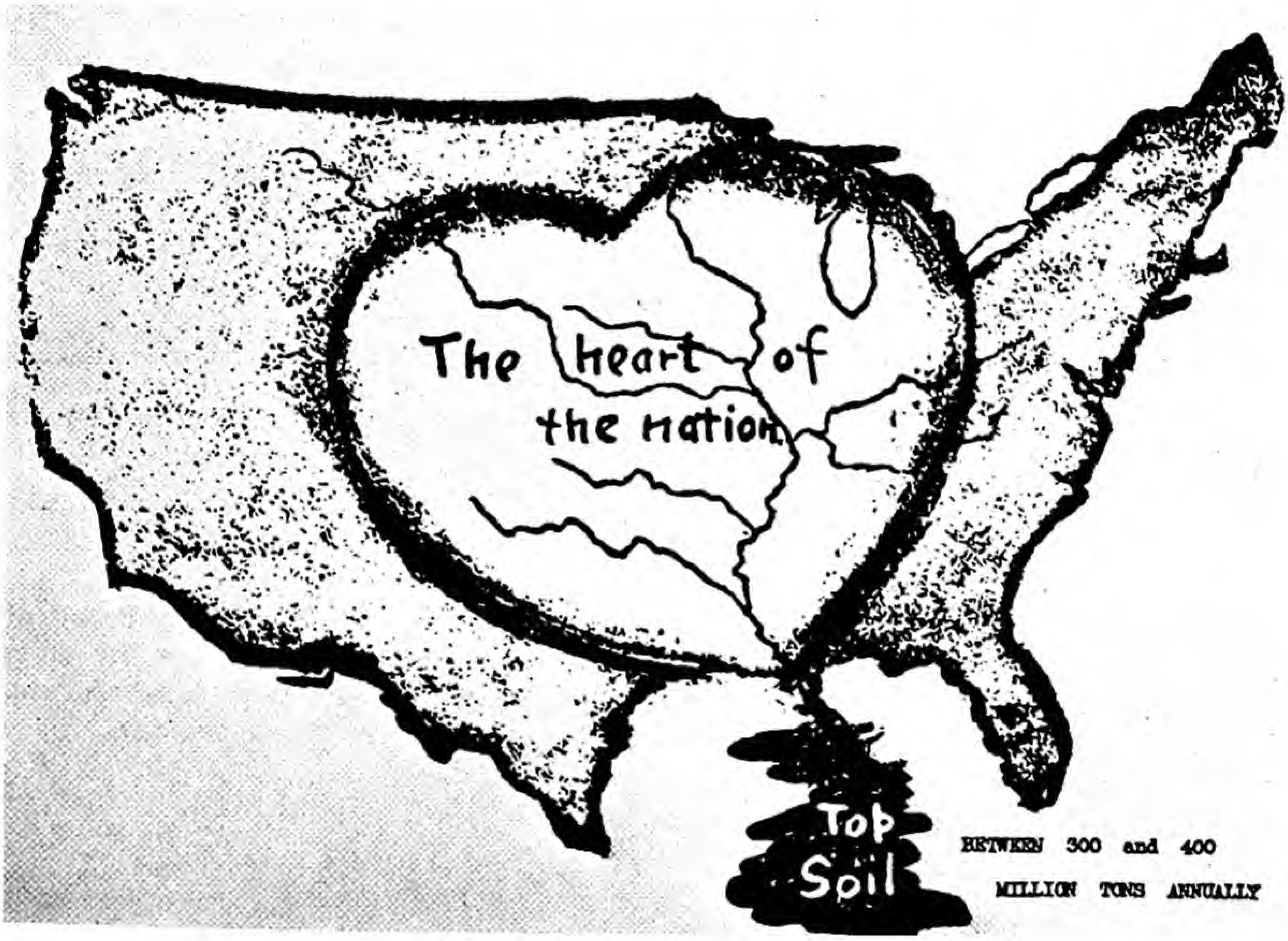
Just as there are different kinds of thieves, so there are different types of erosion. Gully erosion cuts deep grooves in a field, and may draw into it whole farms, roads, and buildings. The life history of a gully begins very simply and harmlessly. If land is level, after a rain water droplets are absorbed into the dust and no damage is done; but, if the ground slopes, it is a different story. Each drop hesitates, then makes a short dash down the slope, picking up particles of dust as it goes and leaving a tiny trail in the soil behind it. The trail seems small, but the next drop that lands in it does not hesitate. It picks out the path with accuracy and dashes over the smoothed track with increased speed. So does every succeeding drop, each wearing the trail a little deeper. Other drops join with those in the main track. Soon the procession of single drops grows to a steady trickle. Trickle joins trickle and before long there is an increasing stream speeding down the hillside. The gully is begun.

So it goes that the faster streams travel, the more soil they carry, and the more soil they carry, the faster they cut into the ground. A mere track becomes a rut, the rut a ditch, and the ditch a gully. The gully cuts back up the slope and lateral gullies cut back from it on either side. In a few years, the field is carried to the ocean's bottom. Millions of acres more will follow the fifty million already ruined by erosion in the United States, unless every man and woman begins to save the soil from gully erosion.

Fortunately, this type of erosion can be seen and its dangerous character easily recognized. The farmer who has lost a cow in a gully, or sees erosion creep up towards his barn needs no other reminder. He knows that erosion must be tamed quickly.

Sheet Erosion

Sheet erosion, on the other hand, is a secret process which may go on unnoticed for years. While gully erosion cuts out great sections of soil, sheet erosion skims over the entire surface of a field, carrying away only a thin sheet of soil. Unfortunately, too, the top few inches of fine particles are by far the most produc-



We now know that a nation can bleed to death.

tive. Sheet erosion, unlike gully erosion, can and does occur on land which slopes only very slightly. Most often the two kinds of erosion occur together.

Probably the surest way to detect the activity of sheet erosion is to watch the streams into which a field drains. If the water is muddy, it is a good indication that sheet erosion is at work. Water moves slowly over the surface and, therefore, can carry only tiny particles of soil. Towards the end of a season, however, even slow-running rills have worn slight channels in which the water moves faster. Exactly the same process that cuts out gul-

Wind, like water, may also be a soil thief, gnawing at the earth, building up great sand dunes such as this one in Texas.

as is washed annually into the sea by the Mississippi River." Tourists on roads 500 miles away from the storm had to turn on their lights at high noon to see the road! Here again we must watch that train of ten-ton trucks, thousands of miles long, hauling away our nation's wealth to be dumped as waste in the ocean or elsewhere hundreds of miles from its source.

The most famous example of wind damage in modern times is the now-famous dust bowl, including millions of acres in Texas, Oklahoma, Kansas, Colorado, and Nebraska. After the war in 1918, when the soil was cropped almost to death and the organic matter largely gone, the soil disintegrated into little more than fine dust which the wind lifted and carried away. Roads and fences were buried out of sight.

Combatting Erosion

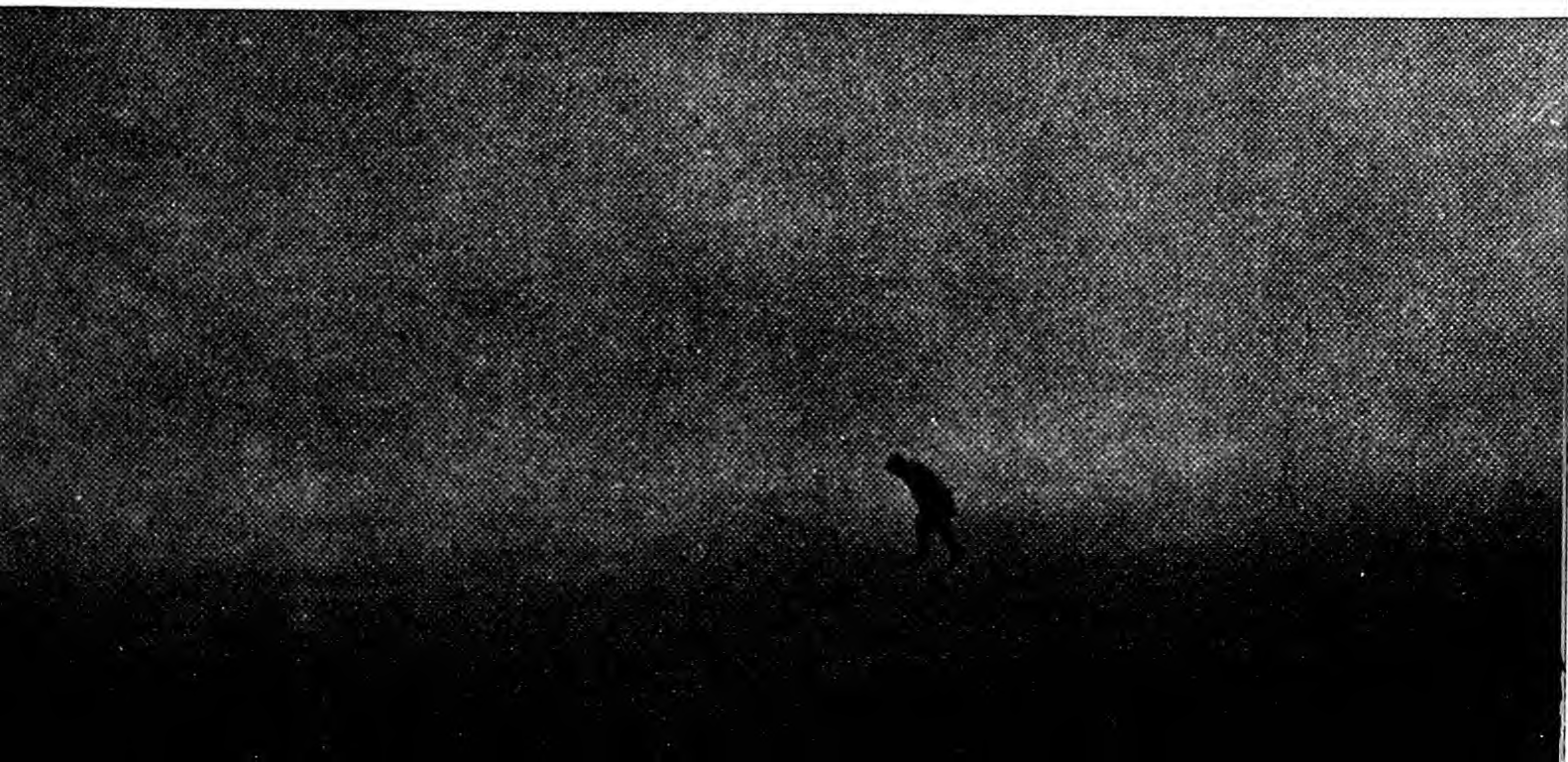
The remedies for wind erosion differ. On the dry, western plains native grasses must be sown where the land has been

cropped. The big problem must be to provide some organic matter for the soil to increase its absorptive ability and make way for a permanent sod. The original crumby structure of the soil must be rebuilt. Where possible the depleted soil should be fertilized. In some places windbreaks may be planted to lessen the force of the wind. It will require the expenditure of many millions of dollars and much labor to remedy the damages that have resulted from wind erosion.

The damage from erosion, whether it be caused by wind or water, and whether it be the gully or sheet type, is greatly determined by the cover spread over the soil. Water and wind can not attack soil which is guarded with a covering of trees, grass, or close-growing crops. The United States Department of Agriculture has set out to study the relation between cover and erosion. From experimental plots in 13 widely separated agricultural regions, it was found that the loss of water from clean-tilled fields was 7 times greater than the loss from fields protected by close-growing crops, such as grass and legumes. The loss of soil was 174 times as much as from protected areas. These plots were typical of soils throughout the country.

Forests allow the rain to be absorbed and thus prevent water from running off and carrying along soil. An example from France will serve to show the importance of forests in soil conservation. Louis XIV was one of the great kings of that country, and his minister of finance, Colbert, was a practical conservation-

When vegetation is gone from the rich prairies and plains, black blizzards of fine soil begin to blow. Any dust in the air is a sign that the wind is stealing the topsoil.



Grass and trees planted at the spot where water first begins to cut into the soil will head off gullies. The area should be fenced from livestock. This Wisconsin gully planting will give homes to wildlife.

ist. Colbert realized that forests were needed to keep soil where it could be used. He appointed a committee which drew up the Forest Ordinance of 1669, a policy which has ever since been the basis for all forest laws in France. Permission had to be granted by the Government before any forests were cut in the Alps and Vosges Mountains. The wisdom of this provision was proven after the French Revolution a hundred years later. The peasants, freed from their old laws, for a time cut the protecting timber on mountain slopes. Within ten years the rich vineyards of eight provinces were so deeply buried in the debris washed down from the mountains that they had to be abandoned.

All vegetation acts in much the same way as the forest, in proportion to its thickness or density. When the cover is undisturbed, there will be little or no erosion. But break the cover, expose the mineral soil, and erosion is likely to begin at once. When soil is in good condition, and contains a high percentage of organic matter, the soil particles are bound together into small clods that offer good resistance to water and wind. When the soil is overworked, and the organic matter worn out of it, the clods fall apart.

Kudzu vine is a miraculous gully healer. This second year growth in Georgia demonstrates complete control of erosion.

Fire is one of the most active agents in destroying cover and thus allowing erosion to begin. It not only kills the vegetation, but it also destroys the natural mulch and burns the organic matter out of the soil. The roots that normally bind the soil in place die and lose their grip on the soil particles. Raindrops beat directly on the unprotected mineral soil with full force, loosen the soil and carry it away. One break in the cover is all that is needed for water to begin gnawing its way through an entire field. Wind whips at the soil and sends it flying.

Overgrazing acts in much the same way. When forage is eaten off completely the cover is largely destroyed and offers little resistance to water and wind. Ungrazed grassland has about the same absorptive capacity as forests, but an overgrazed pasture absorbs little more water than a bare field.

An example from this country will show the result of breaking through the protective cover. When the forest on an Alabama hillside was completely removed and the surface burned over, water from the cut-over area began immediately to cut gullies across the field below. The field was turned into pasture, but was heavily overgrazed. Only 10 years later, a gully was cut 10 feet

deep, and from 12 feet to 30 feet wide. A cow could hardly cross from one side of the pasture to the other. If only a part of the timber had been carefully selected for cutting, or, if the pasture had been moderately grazed, erosion could have been checked.

Another factor important to the soil conservationist is kind and condition of soil. Since the particles of sand, for example, are comparatively large, the openings between them are also large and water is quickly absorbed. The openings between particles of clay are so small that water enters them slowly. Clay absorbs much more water than sand but requires a much longer time. When clear water is absorbed by the soil, it leaves no trace. But, when muddy water sinks into the earth, particularly into clay, the pores in the soil are quickly clogged and the surface is sealed. Later, practically all the water runs off the surface. If there had been a crumb structure in the soil built up by the roots and stems of grass or brush, the water might have filtered through and been clean before it reached the mineral soil.

The condition of the soil is just as important in controlling wind erosion. A collection of roots and smaller rootlets changes dust into chunks of earth which are much too large to blow. The more vigorous the root systems, the stronger will be a soil's resistance to blowing. Consequently, a run-down soil which does not allow the growth of healthy roots is much more likely to erode than one in which the fertility has been maintained.

An important factor in controlling water erosion is to lessen the slope and thus reduce the consequent speed of the water. This principle determines how much soil a stream will carry: still water floats only particles that are lighter than water; moving water increases its carrying capacity according to the sixth power of its velocity. In simple English, this means that a stream moving at 10 miles an hour will carry a pebble weighing 2 ounces, while a stream flowing 20 miles an hour will carry a pebble weighing 32 times as much, or 64 ounces—the sixth power of 2. It must not be inferred that the stones will be carried at the same rate as that of the current. They would be moved very slowly. A little trickle starting down a furrow can pick up grains of dust; but, when another and another join it, the stream at the edge of the field gathers such force that eventually it can roll anything up to the size of cobblestones.

Contour plowing is one of the simplest methods of lessening the slope. A furrow plowed up and down a slope is a gutter inviting water to flow. Water is never slow to take the advantage. A furrow plowed across the face of the slope is a small dam that holds the water long enough for it to be absorbed. This furrow alone may be sufficient to stop surface run-off if the flow is not too heavy. Where the slope is steep and the stream rapid, the plow-furrows may overflow and the accumulated water cut through one furrow after another. A gully will probably start. In such places more effective measures are necessary.

Terracing is very effective on steep slopes. A broad, shallow terrace is made which slopes back into the hill. The ridge is not high enough to interfere with cultivation, but has the capacity to hold all the water from heavy downpours. A series of terraces almost always will keep steep hillsides from washing.

In general, then, the means for stopping erosion by water consist in making running waters walk. The surface run-off must be reduced and its speed controlled. These are safeguards before a field or hillside is attacked by erosion.

To halt a gully once it has begun, one must go far back to its source where the water first begins to flow. Sometimes the start

Poorly managed soil eventually becomes useless. Here much of the land has been destroyed by gullies, yet straight-row cultivation is still practiced.

may be as little as the drip from a barn roof. At the head of the gully a dam must be built. It need be neither elaborate nor watertight. It may be built of dirt, loose rock, or even wire netting. The netting soon catches enough debris to hold water. It does not matter if water seeps through slowly. The dam is designed merely to stop the great downward rush of water. It has the effect of stopping the gully from cutting back into the slope.

To make these small homemade dams more permanent, the area below and above ought to be planted with grass, brush, and trees. These will soon fasten a grip on the soil that will not relax. With a little growth, they will furnish enough obstruction to the flow of water to make the dam unnecessary. Dams and plantings must be repeated down the gully near enough to prevent the water from gaining great headway and speed at any point.

Gully erosion can be stopped effectively if only we start soon enough. France has stopped erosion in more than a thousand streams on her mountain slopes by planting them to vegetation, and thus reducing the water flow to normal.

Another effective means of stopping erosion is through strip farming. This method is valuable in halting damage from both wind and water. It consists in leaving alternate strips of grassland, field, forest, and crops. For example, a strip around the top of a steep slope might be left in timber to prevent water from running down over the brow of the hill. Below that might be a strip of some cultivated crop like corn or cotton. Next there might be a strip of grassland, and farther down another cultivated crop. A strip of crops is alternated each time with a soil-binding crop. All strips are laid out on the contour and follow around the slopes. No cultivated strip is wide enough to shed more water than can be absorbed by the strip below it.

Extremely steep slopes should be kept continually in grassland or forest, and great care must be taken to see that the surface is not burned over and the pastures overgrazed. Natural grassland will hold almost as much water as forest land, but closely cropped pasture sheds water like a duck's back.

There are other damages from erosion besides the removal of rich soil from fields. The beds of streams into which the silt is washed are built up so that the streams are quick to overflow. There are, of course, other reasons for floods. Cutting of the

When cultivated crops must be grown on hillsides, they are laid out in narrow strips and alternated with cultivated crops.

Roots of cedars and pines reach into hillside soil, cling to it, and a few years after planting prevent further erosion.

forests has without doubt been an important cause. But this much is true—the causes of erosion are much the same as those creating floods. When water is made to run slowly and drain directly into the soil, both evils are corrected. Stop erosion and the number and destructiveness of floods will be greatly reduced.

Where dams have been built to catch water for power, for flood control, or for navigation, very often the slackening in

This model of hilly farm land shows how strip cropping, terracing, gully control, and tree planting all are brought into the battle to save the soil.

speed of the river causes silt to be deposited in the reservoir behind the dam. In a few years the reservoir may be filled to the top with silt. Some dams that have been built at the cost of several million dollars have thus been rendered useless after ten years. Unless erosion is stopped in our western mountains, this same fate threatens most of our great dams and the irrigated farms that depend upon them.

The temperature of streams is raised when silt fills in and makes them shallow. Many of the better game fish can not live and are crowded out by poorer species. Clear pools become stagnant and filled with mud. They are no longer beautiful picnic locations.

Erosion and depletion, floods and dust storms, are problems which the United States Government has been called upon to solve. It took the most important step in their solution in 1933, when it created the Soil Erosion Service, later called the Soil

Conservation Service. This body oversees the task of applying the conservation practices of strip farming, terracing, contour farming, gully damming, and many others. Wherever possible, it enlists the support of everyone in a community where conservation is of particular need. Saving the soil, the Government here points out, calls for united action over broad areas because:

> Wind and water follow no pattern laid down by man. They respect neither fence lines nor property lines. Soil carried by water moves from the crests of the ridges, down to the bottom lands along the streams. Therefore, if the man on the hillside does nothing to hold his soil and water where they belong, there's nothing much that the man down below can do but grin and bear it when his crops and his good soil are buried by sand and gravel and raw clay from eroded fields higher up.

Through all these means the Soil Conservation Service in many districts is reducing water erosion to a minimum and demonstrating what must be done on a still larger scale.

In the prevention of wind erosion and dust storms, the Government approached an equally large problem. It was originally designed that an enormous "shelter belt" of trees a hundred miles wide be planted from Canada to Texas. Such a shelter belt would serve to check winds in their sweep across the prairies. Since the influence of windbreaks extends outward to a distance of only 10 to 20 times the height of the trees, it has been necessary to plant them at frequent intervals. Activity has now returned to the task of putting small windbreaks on individual farms in favorable places. Planted and cared for individually, they will undoubtedly serve their purpose. When enough trees have been planted, the wind may be controlled.

The larger problem in halting erosion by the wind is one which must be undertaken by all the citizens of the western prairies and plains. This problem is one of restoring vegetation to those areas of the dust bowl which are too arid to support crops. The evolution of this problem will be a slow process. Reestablishing grass sod over the former grasslands will be discussed in a later chapter.

Soil has been called the most valuable natural resource. Yet misuse of the soil would not be great cause for worry if its effects did not reach out and touch each man and woman. Even the

most serious gullying and sheet erosion, the clogging of streams and the silting of reservoirs would hardly be worth attention if each evil were not so closely bound to all society.

But, when land is misused, not the farm family alone, but everyone in the community must pay the fine. When farms wash down the river or are blown far out to sea, the families who dwelt upon them must pick up their belongings and move. Grocers and lawyers and doctors find it hard to make a living if they remain behind. When the costs of running schools and maintaining roads is borne by fewer people, taxes must be boosted.

Just as desolate is the community which has settled upon poor land, or land not suited to the purpose to which it is being put. Such land is called "marginal" when it is just at the economic border where a family can barely make a meager living but can never get far beyond poverty.

The failure of farmers on marginal lands and poorer or "submarginal" lands is gradually leading men to believe that soil ought to be appraised to discover its highest use.

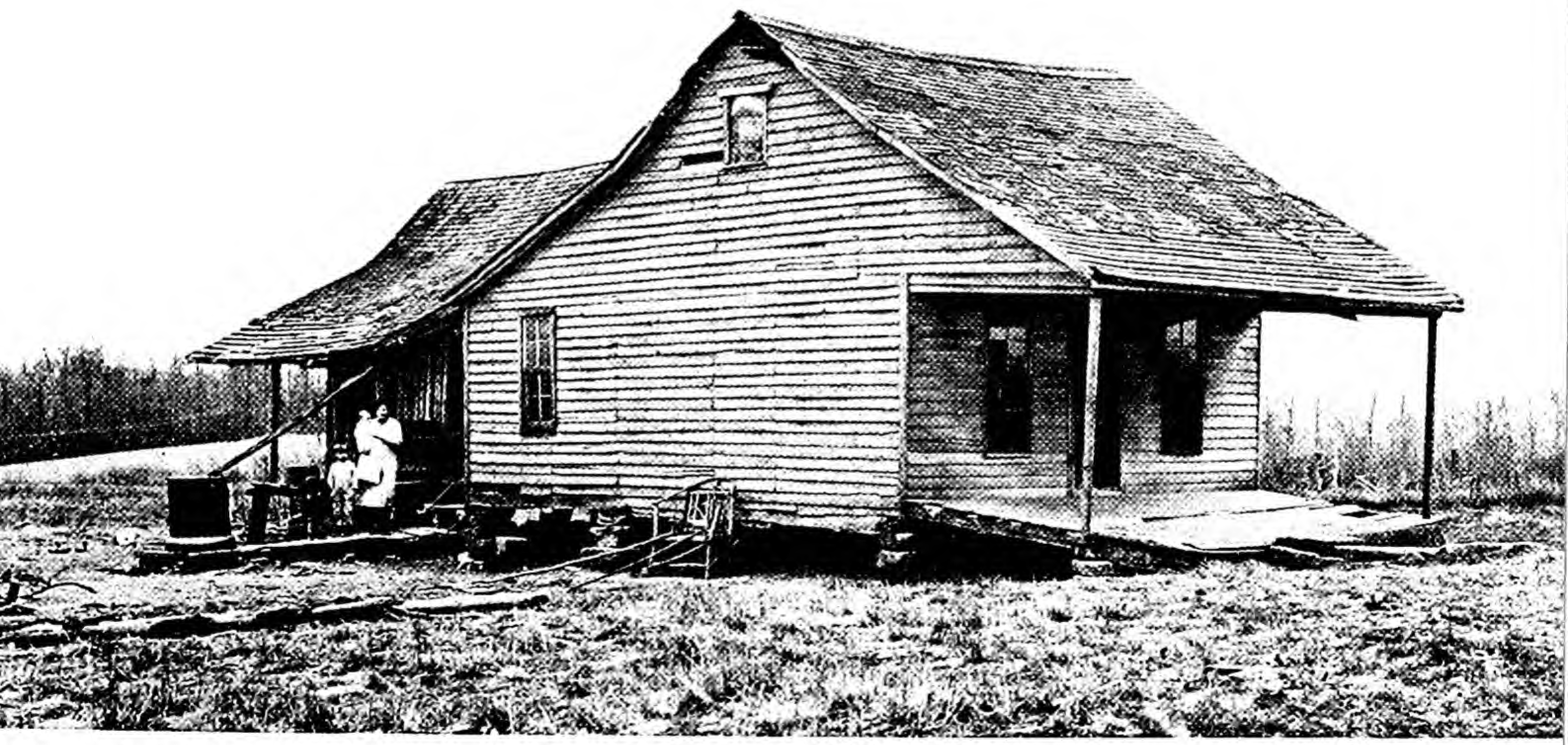
Best Use of Soils

Crop-farming, under ordinary conditions, is the most profitable use for fertile soil. Crop land utilizes roughly one fifth of all the land area in this country. A small part is given over to the needs of cities and villages and mining operations. Most of the remainder is unsuited for crop-farming. Poor soil, inadequate rainfall, rocks, swamps and marshes, mountains and hills each limit the land that can be profitably cropped.

Surely it would be unwise to let this poorer land lie completely idle if there is some use to which it may be put. Fortunately, most land has use—and very important use. Much of it can produce forests that will add revenue to the country, that will protect streams and watersheds from erosion, and provide homes for wildlife. Even more of it can be used for grazing. This fitting of land to the job it is best suited to perform is called "land zoning."

Through planning how land can best be used, men are trying to avoid the errors of the past. They hope to discourage people from settling on submarginal land, with the idea of cropping it for a living. The same land planted to trees might yield a good

Nature intended that this swampy land should produce forest Man tried to make it produce crops. Nature won after a family gave almost a lifetime to the struggle. Now nature with wise help must take up the task of reforestation.



Poor soil results in poor housing, scanty food supplies, and generally poor living conditions. Land should be zoned according to its best use.

profit. Land on the western plains which had been cropped with wheat now furnishes a good living to families who have returned it to sod and allowed cattle to graze.

In order to complete the process of zoning land according to what its best use may be, it will be necessary to correct the old idea that land was never completely useful until it was sown to crops. Too many persons still believe that pasture land, even though it feeds a herd of cattle or a flock of sheep, is lying almost idle. Too many fine forests are cut with the thought that the soil should finally be used for crops. Steep hillsides or rocks might make that course impractical.

Let us walk down a valley of the future where the inhabitants have learned both how to care for their soil and how to make best use of it. High up on the hillsides the slopes are covered with trees. A few men are at work cutting trees here and there, but they leave many more than they take. Farther down the slope where the grade is not so steep, there are cattle grazing on thick pasture.

Bright ribbons of water are being held in terraces farther down the valley, terraces that are gently sloped, and offer no hindrance to the people who are cultivating them. At the ends are grass-paved waterways to carry excess water harmlessly

A valley protected and prosperous.

downhill. On the opposite side of the valley run strips of alfalfa and potatoes and barley, one above another, and following the contours of the hill.

The road crosses a bridge. Beneath is a stream so clear that you can see your reflection in it. As it winds down the hill its edges are guarded by thick plantings of brush and trees. A small dam high up on the slope is stopping the rapid flow of water.

Still farther down is a field which shows the faint scars of erosion and gullies. It has been healed with grass and now is planted to trees. It looks as if it could yield a good yearly harvest of trees, of furs, and of game birds before long.

The whole valley seems to be prosperous. Buildings are neat and freshly painted. The cattle beside barns are fat and sleek. The very air is fresh and cool and free from dust. This valley has planned its way of living to harmonize with nature.

REVIEW QUESTIONS

1. What was the origin of the soil conservation movement?
2. How much time would be necessary before a cement sidewalk, if left to itself, could support grass?
3. Why are some soils in other locations than where they were formed?
4. What elements are needed for plant growth? What are trace elements? Which are most likely to become exhausted?
5. Describe very carefully the proper physical texture of soil. Why is air necessary in the soil?
6. How does the growing of trees and grasses improve the fertility of the soil?
7. What might be the fate of the United States if more persons do not become actively interested in soil conservation? Relate the history of one early country and point out the possible similarity.
8. What are the three chief causes of soil loss?
9. What two forces are at work eroding soil?
10. How can one form of erosion lead to another?
11. Why is sheet erosion more dangerous than gully erosion?
12. What disastrous results followed plowing of the plains?
13. What three factors influence erosion by water?
14. How does soil in good condition resist the action of the wind?
15. Describe the losses by depletion. How may they be cared for?
16. How can the flow of water be hindered? What effect will lessening the stream flow have upon erosion?
17. What is the effect of contour furrows, of terracing, and of strip farming?

18. How can stopping erosion help to control floods?
19. In what ways may shelter belts be valuable to the Great Plains?
20. How can soil, if properly managed, add to every man's well-being?

SUGGESTED ACTIVITIES

1. Gather samples of topsoil and subsoil from several places. In what sort of topsoil does grass seem to thrive? On what subsoil do trees grow best?
2. Survey some adjacent farm or park. Locate the slopes, streams, fields, woods, and pastures. Indicate where erosion has taken place. Make suggestions for protecting the area.
3. Formulate a set of rules which might govern in the selection of a farm. Should land zoning be enforced?
4. Construct a careful map of your state. From the state departments and other sources discover the quality of land in each county. On the basis of crops best grown on each kind of soil, plan where forests, grasses, and farms ought to be. A whole class may co-operate in this activity.
5. If an area is eroding one eighth of an inch a year, how long will it take for the topsoil to disappear, if it is eight inches deep?
6. Send several samples of soil to be tested in your state laboratory. What elements are found to be lacking? Could they be profitably added through fertilizers? Suggest the best uses that might be made of the soil in your community.
7. Give all the reasons you can against the practice of burning meadows, forests, peat, or brush.
8. Plant vegetables in a soilless garden. Your teacher can provide information on how it is done. Study the effects of too little calcium, phosphorus, nitrogen, and potassium. Will the time likely come when the practice may be profitable?
9. Pour half a cupful of water on several samples of soil. Record how long it takes for the water to be absorbed.
10. Visit a gully that has been recently formed. Note what causes have been at work. Use one of the plans discussed in the chapter to put an end to it. Take before and after pictures for the school files.
11. Plan a campaign for stopping soil erosion in your community. Carry it into effect.
12. Prepare posters, displays, demonstration tables, and other devices that will impress the public with the need for soil conservation. Plays, radio presentations, and speeches are good means for teaching.

Debate: Resolved, That planning the use of the soil be left to a carefully selected zoning committee.

CHAPTER FOUR

Our Water Resource

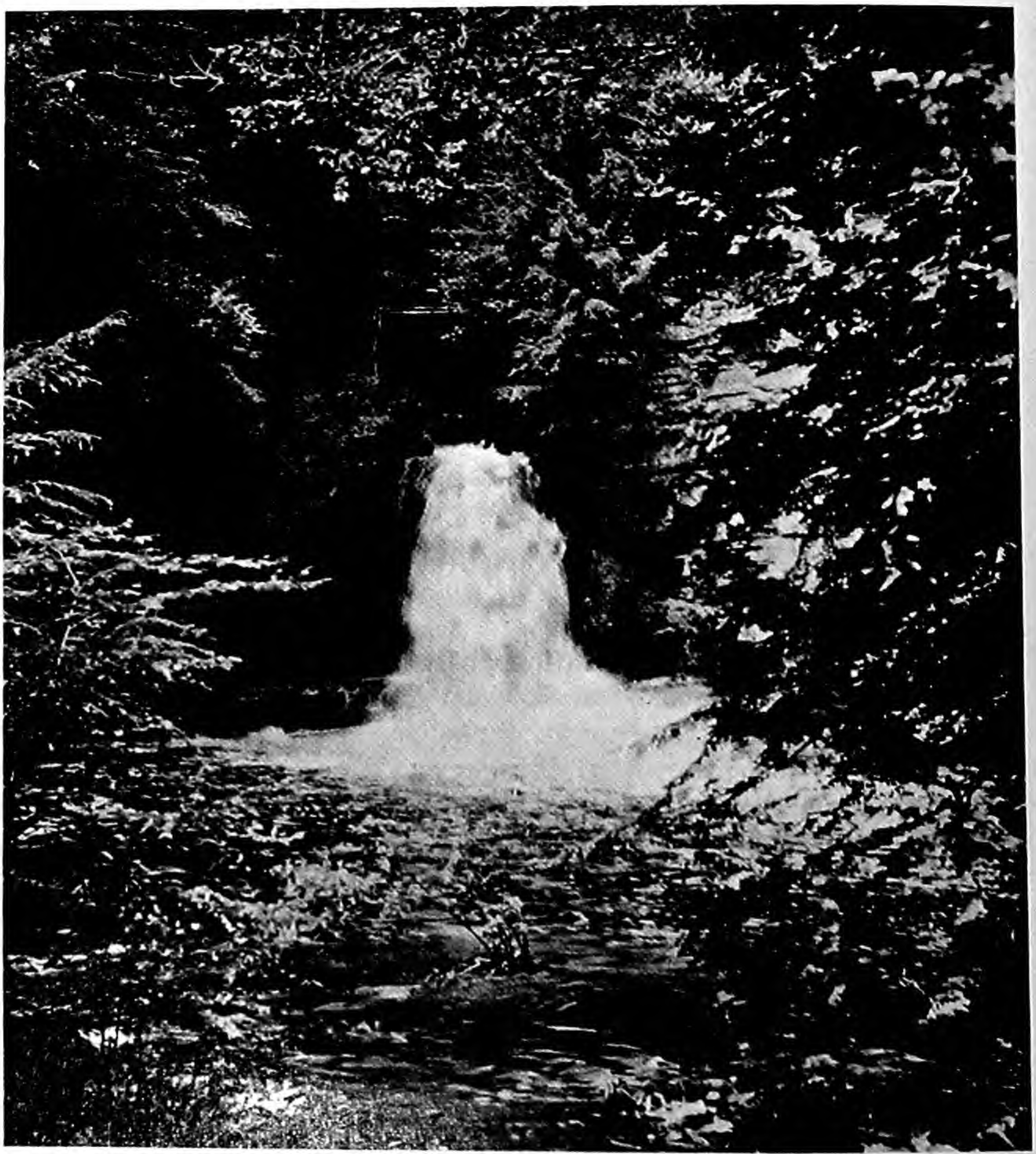
WATER is a precious resource. If you have ever gone without it for even a few hours on a hot summer day, you know how essential it is. Perhaps you have been hiking, camping, or working in the field and have decided then without a question that pure water is an asset too valuable to be reckoned in dollars and cents.

Even though more than three fifths of the earth's surface is water, it is, nevertheless, a resource of great importance. Much of its value is determined by its distribution. Men can not live very far from a good source. On one twelfth of the earth's surface only a very few people live because water is almost wholly lacking. There are other millions of acres where people do live, but where water is scarce and is obtained only with great effort.

Water had great value in Palestine even in biblical times when it was more plentiful than now. When Abraham sent his servant into a distant land to find a wife for his son, it was at the well that the man waited. He knew that all the women of the village had to come there for water.

There is scarcely any life in the vast Sahara Desert except where water comes near the surface at oases. Some students of history think that at one time the Sahara supported a huge population until its water failed and the civilization then died. The Bedouins, roaming over the deserts, carry their water in bags wherever they go. To save water, they wash their faces and hands with sand. In the Near East, Arab water peddlers go from door to door selling water from goatskins which are tied to the backs of their donkeys. They measure out water carefully, since it is a valuable commodity.

Almost all pagan peoples dwelling in dry countries include the worship of rain in their religion. They pray to rain-gods and spirits. Visitors are attracted from great distances to watch the rain ceremonies of the Hopi Indians in Arizona.



Water is a valuable resource. This is Deer Leap Falls in Pennsylvania.

When the Mormons went to Utah, the fertile plains were barren. Water from the mountain streams was deflected to irrigate their crops, and the barren land bloomed. In California the dry Central Valley which now supports the greater part of the

state's enormous fruit industry was virtually a desert until water was lifted and directed to irrigate it. Irrigation has also made possible the use of other land throughout the West.

These are sufficient examples to show that water is a powerful factor in developing a country and in keeping it alive and productive.

The functions that water performs are almost endless. It is absolutely necessary to all plant growth. A plant needs it to dissolve its food and transport elements through the roots and stem. Water must go to make up a part of the tissues as well, since a plant is about three fourths water. Much water is needed to keep the pores in the leaves moist so that carbon dioxide can be absorbed into the plant. Water is needed in the decomposition of organic matter which supplies the plant with nitrogen.

A crop of corn is sometimes destroyed in a few days when a dry wind evaporates the water faster than it can be drawn from the soil. From 10 to 20 tons of water are required to grow a bushel of corn.

Water is no less essential to animals than to vegetation. Man is composed of about four fifths water. On the average, he drinks a ton of water in a year. Everyone knows that, during hot weather, a great deal of water is lost through the skin in perspiration. It is not generally known that large quantities of water vapor pass into the air in breathing. An audience of five thousand in the course of an evening gives off around four barrels of water, which is sometimes condensed in the ventilating system. This is the result both of respiration and perspiration. Water is even more immediately necessary to man than food. He can live without food for a month but no longer than three or four days if he has no water.

In commerce, where it makes navigation possible, and in manufacturing, where it furnishes many million horse power for factories, water is important. Fisheries naturally depend upon water.

What are the properties of water which determine how it must be wisely used and managed?

In the first place, it is almost indestructible. Boil it, freeze it, or spill it over the ground. Still it remains water in one of its forms.

The Hydrologic Cycle

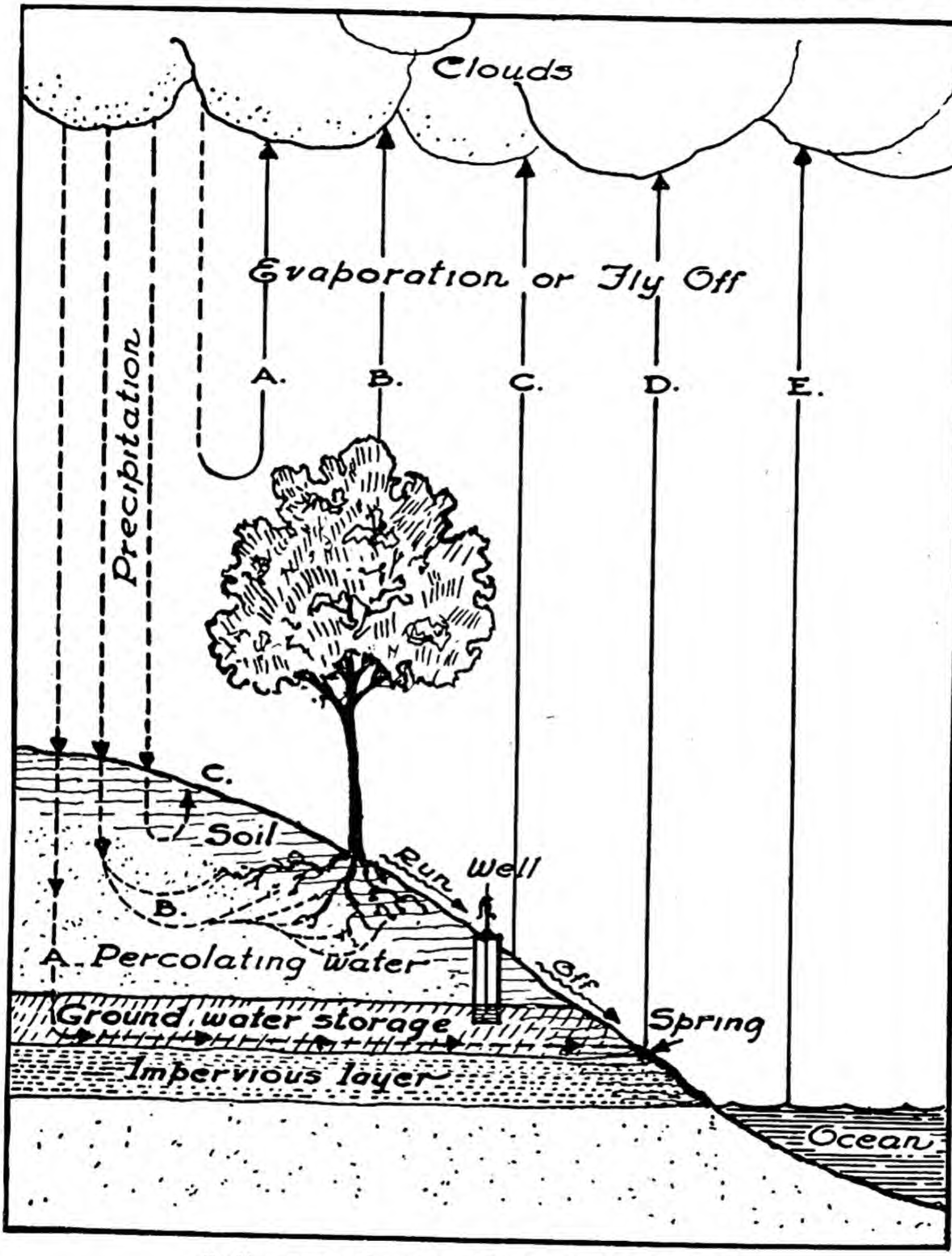
Unlike soil, which leaves the slopes and valleys to be lost for all time in the ocean, every drop of water that reaches the sea returns—in a day, a year, or a hundred years. Every drop that evaporates from lakes, streams, plants and the soil returns again in rain or snow. The circular path that water takes from the time it is drawn up in the air, through its many possible journeys over the earth until it once more reaches the atmosphere, is called the hydrologic cycle. It is important to study, as it is possible to regulate and control water to make best use of it.

The paths water might take during the hydrologic cycle are many. In fact, each molecule might take a different trip. A molecule, you know, is not the same as a drop. It is that tiny combination of two parts hydrogen and one part oxygen which may be frozen or evaporated, and still keep its same form. There may be a myriad of molecules in a drop. If a glass of water were poured into the Pacific Ocean and allowed to mix with all the water in the world, a new glass of water drawn anywhere would contain 10,000 of the molecules from the first glass.

Let us watch one particular molecule of water as it travels over the earth in many disguises. On some bright day, the thirsty air snatches the molecule out of the ocean and carries it high up into the air. Even in the atmosphere, water in the form of vapor performs an important service, surrounding the earth with a blanket of moisture that prevents the rapid escape of heat through radiation. If it were not for the covering of vapor, the temperature on earth would be about 300 degrees below zero. It is said that the water vapor normally in the air does more towards keeping us warm than all the fires we can build, the food we can eat, and the clothing we can wear.

Along with millions of its friends, the molecule, perhaps fifty miles inland, meets a chilly breeze from the North and begins crowding together with the others. Many of them have been pushed together so closely that they form a drop and fall earthwards with a rush. Countless other drops fall all about them, taking part in a rain storm. Some drops fall into a stream and soon reach the Gulf of Mexico or the sea. Some fall on an open field, penetrate deep into the earth, and trickle into an under-

ground stream. They wander through dark channels with rocks above and below. After a long while they suddenly bubble out



A diagram showing the hydrologic cycle.

into the sunlight in the bottom of a cool spring. They, too, eventually reach the Gulf or the sea.

But the original molecule in its drop of water perhaps falls in a forest and slips from leaf to leaf until it reaches the ground. Down through the litter and humus it seeps. Here the drop drinks in nitrate and potassium molecules, bumps into a root-hair, and is drawn through a semi-permeable membrane into the root of a tree. A mysterious force draws the molecules of water and plant food upwards along the stem. Up until they reach a leaf the molecules go. Here the food molecules are taken away and the original molecule squeezes out through a very small opening or stoma back into the air, completing the hydrologic cycle.

As the drops of rain fall, they travel by different routes until their cycle is over. Some cycles may take a long while to complete. Others may be over in a short time. The paths which water takes in its land-journey allow it to be classified.

That which falls and is shed off at once to return to large streams is called surface run-off. It renders almost no benefit to man, and is the type which does great damage in the form of floods and erosion. It is the type which must be constantly watched and kept under careful control.

Surface run-off may be held and turned into soil water and ground water. This Oklahoma field is absorbing a heavy fall of rain.

At times the water table appears at the surface as a marsh, swamp, or spring. This Missouri slough gives evidence of an abundance of ground water.

Water which penetrates the surface only a short way is called subsurface or soil water. Much of it quickly escapes by evaporation through the soil's crust, particularly when it is not cultivated. Often this soil water overlays perfectly dry earth in which no roots can grow. One might expect cactus to be very deep-rooted, but its roots are spread widely and lie just below the surface, ready to catch the scanty rainfall of the desert before it evaporates. Most plants live on this soil water which is temporarily stored in the upper three or four feet of earth.

Some of the water, and a very important part, makes its way through the surface soil down to the ground water storage or reservoir. This is a great body of water within the earth that supplies our wells. It is the greatest of all the reservoirs of fresh water and into it goes about one sixth of all water that falls. The

top of this reservoir is called the "water table." Occasionally the water table comes to the surface in the form of marshes and swamps. In some places the water table is only a few feet below the surface. On the coastal plain of Florida, graves can not be dug without striking water. Vaults must be built above ground.

Ground water flows for great distances through veins of gravel and coarse sand, often coming to the surface at unexpected places. Wakulla Springs, Florida, is a good example. Located within a few miles of the coast and not over 10 feet above sea level, this broad spring pours out great quantities of beautifully clear, sweet water from an opening 185 feet deep. This water must have come from mountains several hundred miles away. Its age is evidenced by the fact that both mastodon and elephant bones have been found in the bottom.

Sometimes water-bearing veins of gravel are located between two strata or layers of impervious rock that have been tilted at an angle by the great forces developed within the earth. Water piles up in the sloping channels and develops considerable pressure. When an opening occurs in the lower part of the channel the water spurts out, often with force enough to carry it many feet in the air. Such water is known as artesian.

Water Waste and Misuse

Water is so generally abundant throughout most of the United States that it is perhaps wasted and misused more often than any other natural resource.

The most common means of misuse is by pollution. Mankind has been taught to believe that when any waste is thrown into a stream or lake, it is safely disposed of. And this belief, to an extent, is true. The oxygen uncombined or found free in water —not that which goes to make up the water molecule—is active in oxidizing or "burning" up the wastes and changing them into simple compounds. But there is a limit to the amount of filth that can be disposed of by even a good, active stream. We have too much faith in the idea that flowing water will purify itself every few miles. Most streams and rivers are reeking with the refuse of farms and villages and cities.

Large cities have always found it convenient to dump their sewage into neighboring rivers, disregarding the fact that the

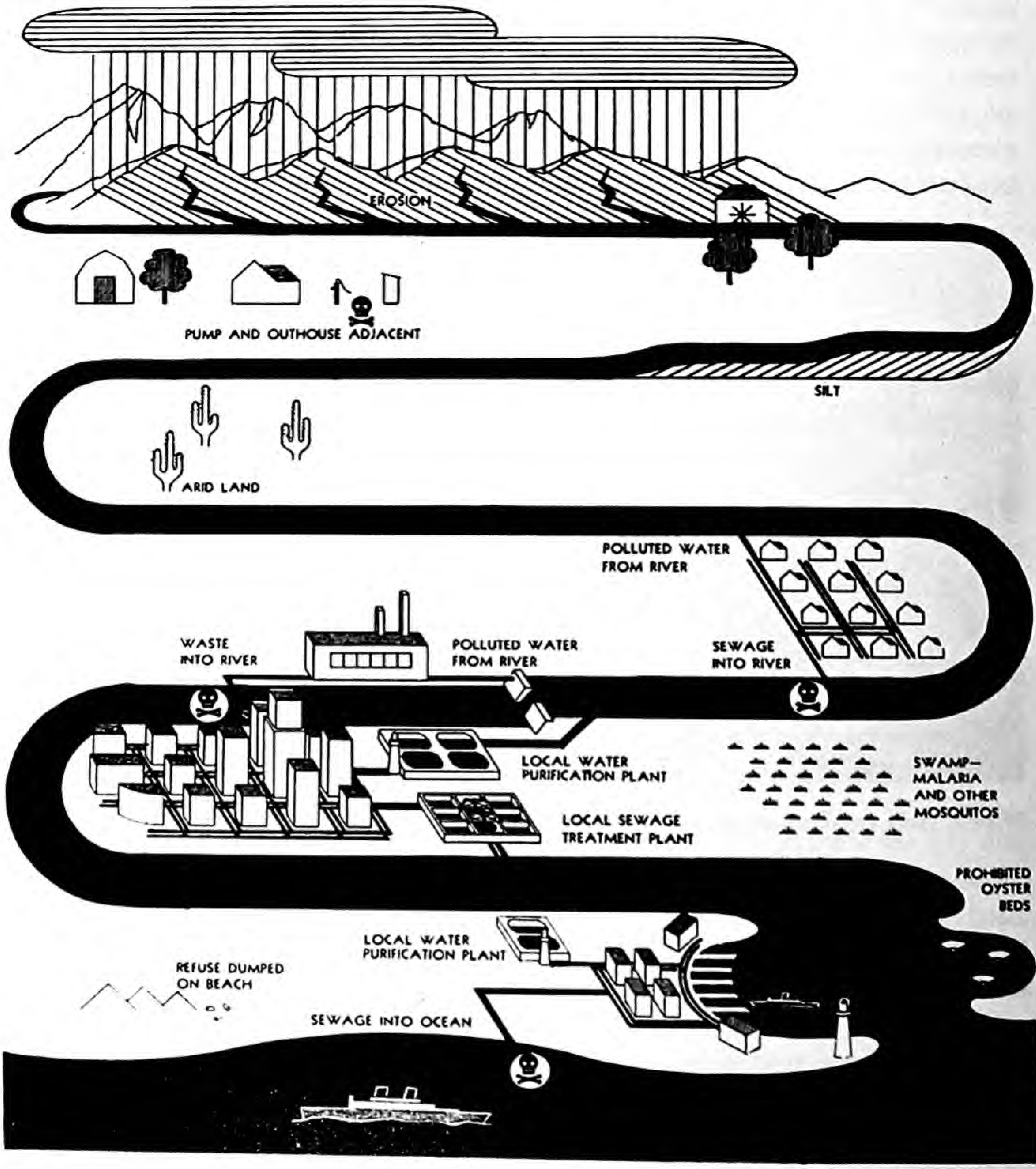
next town below must get its drinking water from the same stream. The second town dumps its sewage into the river without heed to the cities below. In fact, three fifths of the total urban population discharges its sewage without treatment into our rivers, lakes, and streams. Almost 41 million city people are helping, most of them without knowing, to pollute the waters of the

When fish and sewage must battle for oxygen, fish are always the losers. Even carp can not live in badly polluted water.

nation. Half of the population has no sewers. Much of its wastes go directly into small streams. A hundred villages and towns dump their sewage into the Great Lakes and take their drinking water from the same source.

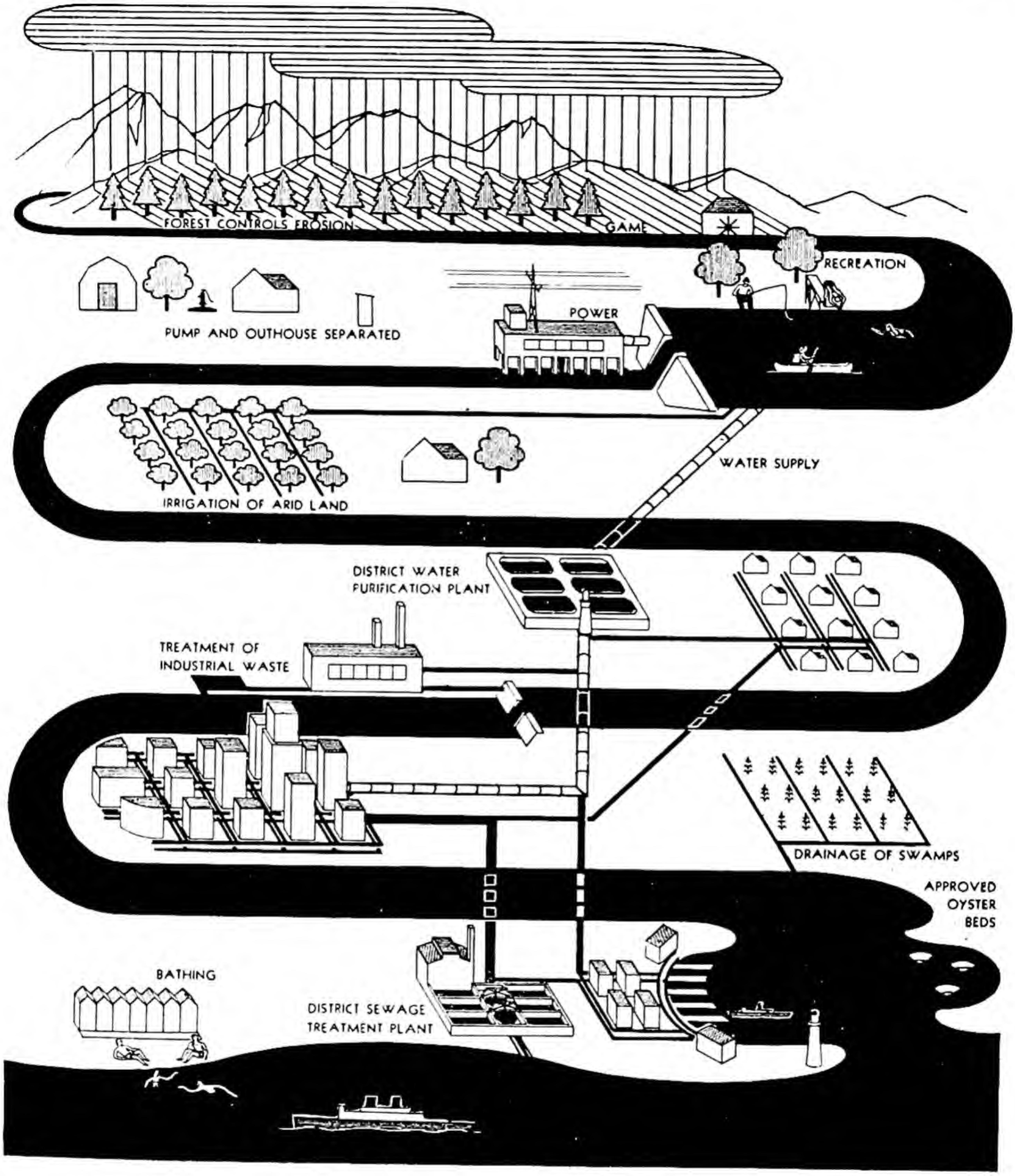
Lakes and streams often become so polluted that they are unsafe not only for drinking purposes, but also for swimming. One river was so filled with sewage that a great university did not allow a rowing crew to train on it for the annual regattas.

Sewage before it can be converted into soil and simple compounds takes much of the free oxygen in the water. The supply of free oxygen below cities sometimes runs seriously low. Even if the stream is able to purify itself, so much oxygen is required in the oxidation that there is not enough left for fish. When fish and sewage must compete for oxygen, fish are always losers.



Unplanned River Development

When river development is unplanned, soil from hillsides is washed into rivers, causing soil loss and silting. Irrigation opportunities are neglected. Waste is permitted to pollute the water. Recreation possibilities are destroyed. The lack of planned use results not only in the loss of many benefits but works a positive harm to the community.



Planned River Development

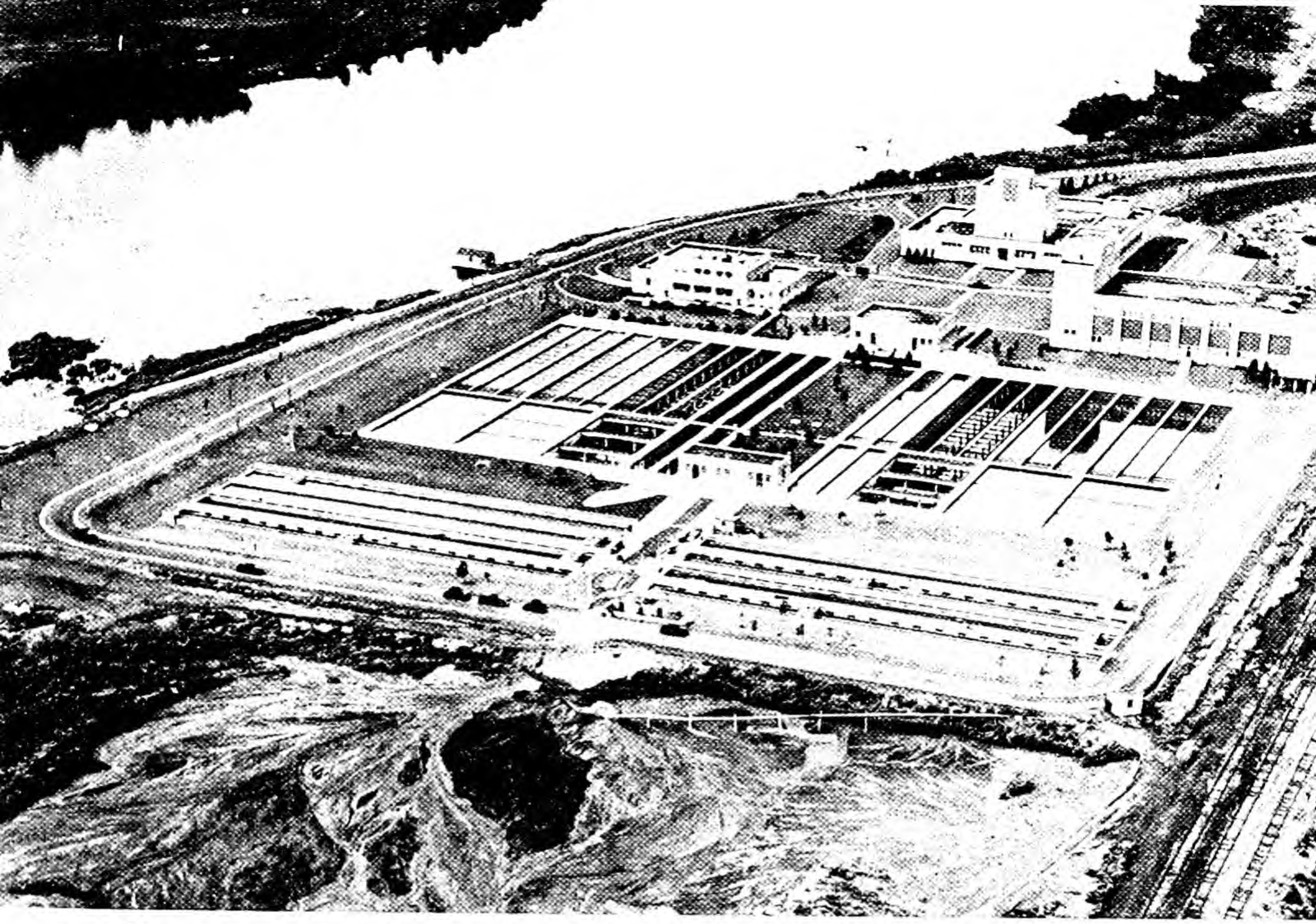
Planned river development means that hillsides are planted to forests, which not only prevent erosion and silting but provide homes for wildlife. District purification plants and proper treatment of industrial wastes insure a supply of pure water. The river is used for both power and irrigation. Recreational facilities abound. Only by careful planning can this valuable resource be put to its best use.

A stream of sewage and industrial waste enough to fill a trainload of tank cars reaching around the world, formerly poured yearly into the Mississippi River at Minneapolis and St. Paul. A scum collected over the water.

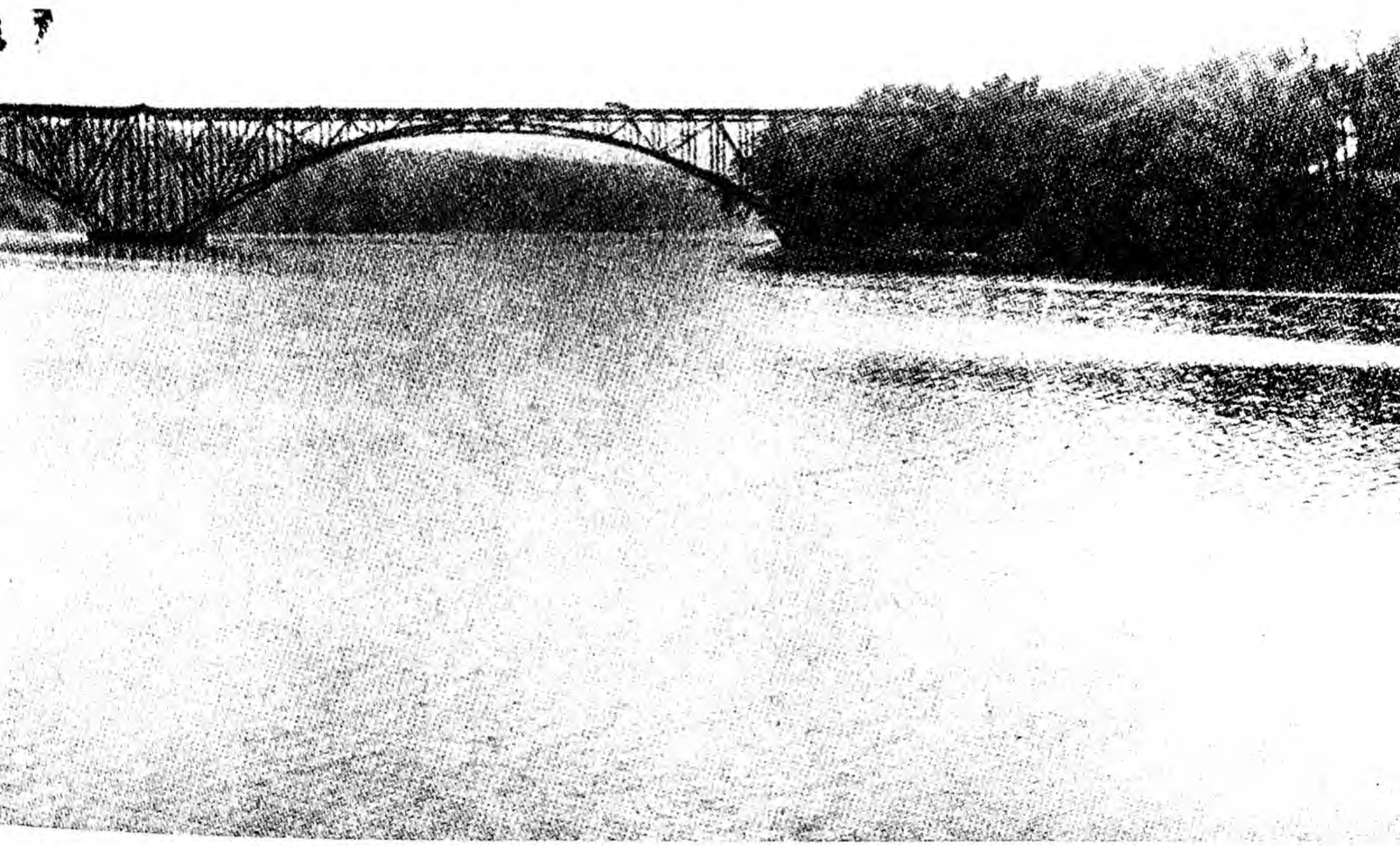
Here is an important loss to the nation. Oceans and lakes are our untilled acres. It has been said, and there is reason to believe it, that an acre of water can be made to produce as valuable a crop as an acre of land. Certainly the quantity of fish produced in some ponds is remarkable. Between 300 and 400 million cod are caught annually off the Atlantic Coast, more than half a billion salmon on the Pacific Coast, and more than five billion herring off the coast of the Scandinavian countries. The commercial catch of fish all over the world amounts to more than a billion dollars a year. This is merely the commercial side of fishing. Water must also be credited with the recreational value of fishing. Thousands of people forget their worries every year, sitting for hours at a time watching an unexcited bobber.

If sewage and waste continue to pollute rivers and lakes and coastal waters, fish for food and recreation will become increasingly scarce. Many territories famed for their clear water and excellent fishing are losing valuable tourist trade from pollution.

Sewage from cities is not all that pollutes water. The waste products of coal mines, gas plants, paper mills, textile mills, canneries, packing houses, sugar refineries, chemical plants and



Now a modern sewage disposal plant reduces all filth to ashes. The plant and its connecting sewers cost $10,450,000, but its yearly cost to the cities for building and treatment is only 70 cents a person.



Already game fish have begun to swim again, and the Mississippi is returning to a beauty almost forgotten.

many other kinds of manufacturing plants are being dumped down the banks of hundreds of valuable streams. The volume of sewage sent to plug our waterways is tremendous. Often there are acids which are poisonous to fish.

The germs of several diseases are water-borne. Typhoid fever is probably the most dreaded. Ever since it was discovered that impure water was the source of the disease, sanitary measures have been in effect, and few epidemics have occurred. Typhoid used to be one of the greatest dangers of war, often killing more men than the actual combat. As recently as the Spanish-American War, more than 1,500 American soldiers died of the disease. In most cases, the source of infection was the polluted water that men had to drink. Although there were 14 times more American soldiers engaged in the war in 1918, less than 200 soldiers died from typhoid.

Oysters that grow in the range of discharged sewage feed upon it and are often the means of spreading typhoid. Many places at one time famous as recreation centers and good fishing grounds are losing their tourist traffic because their waters are polluted. Nothing drives the public away from a resort any faster than a rumor that the water is polluted, unless it be the foul odor itself from waste.

Silt from erosion fills rivers and lakes with mud. Often trout and other game fish are choked out, with the result that less desirable fish come to take their places. Silting of rivers and lakes may be called another form of pollution.

Controlling the purity of our streams is a problem which calls for the joint co-operation of all states and the Federal Government. It has already been said that rivers know no political boundaries. Pollution of a stream in one state may vitally affect the interests of another. One river drawing from vast headlands may affect five to twenty states.

Sewage disposal plants have been built to care for the wastes in many cities. But these are expensive, and progress has been slow. There is real need for immediate work in this direction, however, since money is of small value when the human resource is endangered. Several industries have discovered to their surprise that caring for their wastes has provided them with a profitable new by-product. The pulp and paper industry found

good use for sawdust in helping to make alcohol and artificial silk. Proteins were recovered from wastes in the meat-packing industry. Cattle food was made from distilling slop. A casein plastic base was made from milk wastes. Cities have paid their sewage disposal costs with the by-product of fertilizing material.

In the country it might be wise for every boy and girl to trace the source of drinking water for the community. Perhaps a stream could be followed to its head. All along the way might be found homes and farms that are allowing wastes to corrupt the water. In every case, there are means for disposing of sewage in a sanitary way.

Besides pollution, a second great mistake has been made in dealing with the water resources of the nation. During the years of agricultural expansion, the same mad rush that drove men to cultivate what is now the dust bowl area, led them to drain or "reclaim" swamps and marshes. Large bogs in the North looked level, and the rich black muck in the bottom gave promise of good farming land.

But swamps, marshes, and bogs were not all alike. Some were covered with peat which varied in depth from one foot to twenty-five feet. The soil beneath the crust of vegetable matter varied from heavy clay to rocks. Drainage ditches were dug with little thought to their advisability. Very often the reclaimed areas became too dry for cultivation. The peat was likely to catch fire and burn down several feet, leaving a soil usually poor in potassium and phosphorus. The swamps, which had previously offered a barrier to stop fire, now became a fire hazard. Fires burned for months in the peat. The bogs became storehouses from which fire might burst out at any time and burn the surrounding country. Several Minnesota towns were destroyed from this cause, and hundreds of lives were lost. And still settlers who had been sold such drained swamps continued to set fire to the peat, hoping that the land might be fit for farming.

The reclaiming of swamps, moreover, became a corrupt scheme for making money. Permits were granted for digging ditches which nobody but the ditch-diggers wanted. Thousands of acres of drained swamps and marshes are lying idle today, and the cost of the ditches when it was assessed as taxes has driven the people out of large areas.

A further serious result of drainage has been a great loss in the height of the water table. The unwise tapping and flow of artesian water, the increase in erosion, and the removal of vegetation have all contributed to lowering the water table, but drainage of the swamps has also been an important cause. The fact that the water table has dropped in places as much as 40 feet is a matter for serious thinking. Springs stop flowing. Wells dry up, often forcing great stretches of pasture to be abandoned. Trees die off. The flow of streams is reduced. Cities and villages must find new supplies of water.

Another less obvious loss caused by a drop in the water table is the cost involved in deepening wells and lifting water higher than before. With millions of wells pumping water from the water table, a drop of only a foot will force the expenditure of great amounts more of energy to lift the water.

Draining the swamps tapped the natural reservoirs that had held much water. Through the ditches water flowed quickly into the streams and added to the flood waters from other areas. The nesting grounds of waterfowl were destroyed.

The first to show any real wisdom in the matter were the beavers. After several years of protection from trapping, they increased in numbers and closed off ditches with their small dams. In many places they returned poor land to swamp. Some legislatures were wise enough to follow the example and passed laws prohibiting the building of ditches without adequate gates. Attempts are now being made to restore some of the 84 million acres that have been drained to the water-holding swamp and marsh land for which they are best suited.

In the Central Valley of California lowering of the water table has had still another effect. The pressure of fresh water from mountain streams is not enough to keep salt water from the ocean from seeping into the soil beneath rich orange groves. Unless pumping is resorted to, the salt may eventually ruin the land.

Opposite page:

"Drain and ditch!" was the American cry only thirty years ago. Lakes and swamps and marshes were tapped of their water to provide new farm lands. Scene is on the Big Grass Marsh, Manitoba, in 1906.

The mistake was huge. The drained land was too sour, or covered with peat which caught fire and burned. Picture shows the same land 33 years later, after peat fires had been burning all winter.

Seven months after the ditches were dammed, the area had returned to its best use. Pintails, mallards, and scaups once again whistled over the marsh.

The beaver, wise little engineer of the deep woods, has all the while been felling trees and fashioning them into strong dams to stop the rapid flow of water. Given legal protection, he has increased rapidly and now is a real aid in the prevention of forest and peat fires, in the control of silting, and in game and fish propagation. Countless small pools of water that form back of the dams are slowly rebuilding the water resource. The beaver is nature's own conservationist.

Water Power

Let us look now in the other direction, away from the story of abuse, towards a study of how this valuable water resource can be put to its most effective use. In this way it may be possible to discover how the mistakes of the past can be corrected.

Water has been called the "white coal" of industry. There is power in rushing currents of water and in waterfalls. This power ought to be used. A great good is overlooked when power sites are not developed.

There is an important difference in the use of coal and water for power. When coal is burned to furnish power, it is completely destroyed. Water passes through power plants without change. It is simply harnessed for use, and, if properly tended, will continue to furnish power indefinitely. One could figure, if he chose, the actual loss in money every hour that water falls unharnessed in the United States, but the result would not be quite accurate. Often power can not be used at or near where it is produced.

It has taken mankind a long while to develop a means for making efficient use of water power. The history of how man has improved the water wheel from a clumsy, slow-moving wheel into one that will produce 115,000 horse power is a story of gradual discovery. Probably when man first dropped a piece of wood into the water and watched it float downstream, he realized the power in a moving current. Early in the dawn of history, Eastern people began using the "noria." This was an awkward wheel of large diameter with the spokes extending beyond the rim and expanded into large fans of woven bamboo. These fans or paddles were pushed along by the current, enabling small buckets attached to the wheel to be lifted up and dumped into an irrigation trough.

When less water was available, the flow was confined in a trough and the whole stream directed against the wheel. This device made full use of the current and was known as the "undershot wheel." It has been used for centuries. When it was later geared to simple machinery, the undershot wheel was made to turn grindstones, and was hitched to saws that moved slowly up and down every time the wheel turned. Later the trough directed water at the top of the wheel instead of the bottom. This method increased its power, making use of the fall in addition to the current. The contrivance was called an "overshot wheel."

There was one outstanding difficulty in the use of water power. The flow of the stream was not even. There were floods in the spring and fall, and a feeble flow in the summer and winter. But by damming a stream, a reservoir was formed that steadied the flow A fall of water or "head" was created which gave added power.

A contest has been going on continually between black coal and "white coal" to determine which is to serve the nation with

power. When factories first were developed, water supplied the principal source; but, when the steam engine was invented in 1769, it proved a very strong competitor. Whereas mills using water power were confined to the banks of streams, often in places which were dangerous in time of flood, a steam plant could be placed wherever coal could be shipped. Steam power could be better controlled and regulated to suit the needs of the industry. Thus for a time steam power robbed water power of much of its importance.

Water power gained a new place when electricity entered the scene. The first central station for commercial electric lighting gave power to illuminate 800 bulbs in New York City. Although the first station was powered by steam, one completed about the same time in Appleton, Wisconsin, was operated by water power. A little more than 50 years later, production of electricity by water reached an output of 58 million horse power. At present one third of the nation's electricity is produced by water power.

Later improvements in the wheel added still more to the efficiency of water power. Most significant was perhaps Boyden's construction of a 75-horse-power turbine at Lowell, Massachusetts. With the old overshot wheel, as high as 98 per cent of the stream's current and fall had been used, but the action had been slow. More than 40 feet of fall could not be used successfully. The turbine, on the other hand, is small, quick-acting, and can be operated under a head of several hundred feet. It reaches an efficiency of 94 per cent, and the energy it can develop at high speeds under these high falls of water is enormous.

Improvements have been made in the transmission of electricity as well. Power lines have been developed to carry current for 200 to 300 miles without prohibitive cost. This radius is being enlarged with improved means of transmission.

These two factors, the development of turbines and improvements in the transmission of electricity, have given water power a new lease on industry. Turbines are not put out of operation by high water as the overshot wheel had been, and the factory no longer had to stand close to the wheel in the range of flood damage. The turbine can be worked under water if necessary, and its power relayed on to distant factories.

Water power has certainly not replaced steam. Often people think.that water power costs nothing. But this assumption is not true. Although the operating costs are not ordinarily so large, the cost of installing dams and spillways is very great. Steam is often cheaper except where the water power site is close to a dense population, where transmission lines can be short, and where the topography will allow damming the water to furnish a uniform flow. All the present and possible future power in water could produce only one fourth of the energy contained in the mineral fuels consumed in 1937. From the conservationist's view, water power is very important because, if properly managed, it will furnish power forever.

The industrial development of a nation depends very largely on its source and amount of power. Van Hise, one of the most active leaders in conservation, rated the industrial strength of nations on the total number of horse power that could be developed from both water power and fuel. He has listed them in number per capita. China could develop only .12 horse power for each one of her inhabitants; Italy could develop .31 horse power; France has power enough for .97 horse power; Germany could produce 1.5 horse power; England 2.4 horse power, and the United States, 3.6 horse power. This estimate means that America has a great industrial future if water and coal are conserved as they should be and perhaps must be if we are not to suffer.

The developed water power in the nation has doubled in the last 10 years, and now reaches the total of more than 16 million horse power. The total production of electricity at the same time has exceeded 90 billion kilowatt hours, a part of which results from water power. Even so, the United States is now using only a fraction of its available water power. Some estimate that it is one half, others say it is only one fifth.

It is said that a larger share of the pig pens in Norway are lighted with electricity than are American farm houses. The Scandinavian countries have gone a long way toward making the most of their water power. Wide use of water power is one of the reasons why Sweden today has the highest standard of living of all countries in Europe. In America only 16 per cent of the electricity produced is used in the home. The remainder is used by factories and in transportation.

It is not easy to predict how much further our water-power resources will be developed. The Federal Power Commission has made a survey of water-power development in the United States, and has estimated the possibilities for expansion. In this study it divided the country into seven regions. In the Northeast including New England, New York, New Jersey, Pennsylvania, Maryland, and Delaware, the present output could be multiplied more than three times. The same expansion is possible in the Southeast, which includes all territory east of the Mississippi and from Kentucky and Virginia southward. The Mountain-Plain region, including the northern great plains states, Montana, the Dakotas, Wyoming, Nebraska, Colorado, and Kansas, could be increased slightly more than four times. In the Southwest states of New Mexico, Oklahoma, and Texas, much the same development is possible. In the Pacific Northwest states of Washington, Oregon, and Idaho, there is room for expansion by nine times. In the Pacific Southwest states of California, Nevada, Arizona, and Utah, water power might be expanded more than five times.

There is no way of determining how many of the 1,883 power sites listed in the report will ever be developed. Some may be too far from adequate markets; some may be too expensive to develop. The distance that electricity can be transmitted is constantly being increased, however, and the radius of a power site's value is therefore lengthening. It is safe to say that the development of water power will some day be far greater than it is at present.

Much argument has arisen as to what governmental control, if any, should be applied to the development of water power. There seems to be a choice between three policies: unrestricted private control, private ownership under governmental regulations, and Government ownership.

Those who urge that every man have the authority to operate his power site as he chooses, say that power production is highly competitive, and that strong competition enforces the most economical production. This argument is sound where there actually is competition between power sites. Under many conditions, however, competition does not occur. The power site is far removed from any other possible producer, and a monopoly may exist.

Grand Coulee Dam provides a magnificent example of the importance of water as a resource. This huge dam, when completed, will furnish electric power for a great agricultural empire, will irrigate an area of more than a million acres, and, together with Bonneville Dam, will open the Columbia River to navigation.

There are stronger arguments for governmental regulation. The water that develops power at any one place may be drawn from a watershed that extends into several states. The conditions in those states may have a profound effect on the flow of the stream. Developing a power site to only a part of its capacity may be most profitable for a private owner, but complete development might be far better for the entire community.

Many hold the idea that all water power should be owned outright by the Government. They believe that power is too easily monopolized and affects too many people to be entrusted to private ownership. If the Government had owned all water power from the start, there might have been little opposition to the idea. But already many sites have been bought in good faith by private owners. Under present conditions, the best answer seems to be that of governmental control. Such control falls under the office of the Federal Water Power Commission, composed of the Secretaries of War, Interior, and Agriculture.

To insure the best and widest use of our water-power resources, every man and woman can see that certain conditions are protected. The most important of these is an even flow of water throughout the year, and a stream free from silt. They are more or less subject to control. It is impossible to make the

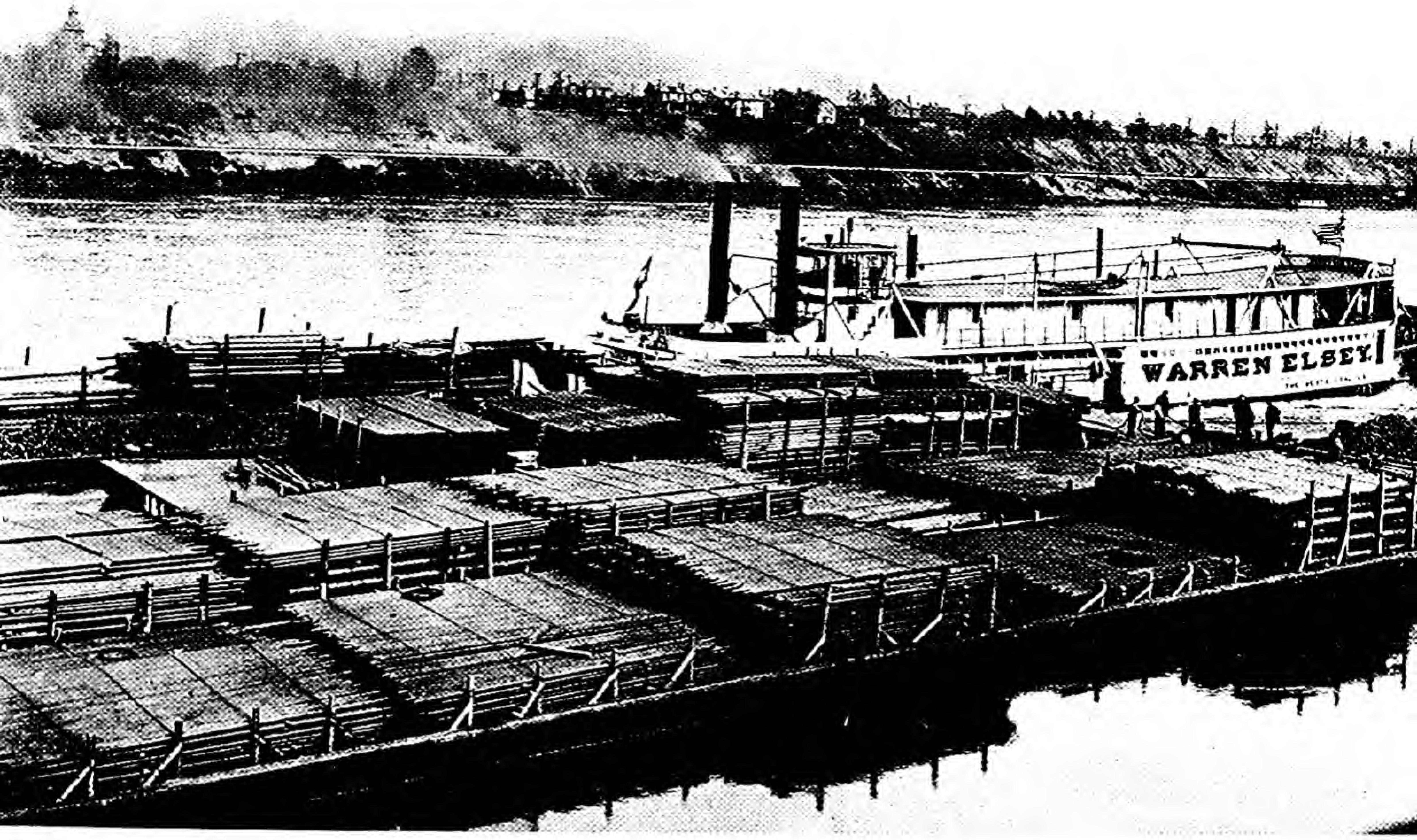
rate of flow in a stream entirely uniform, simply because rainfall is irregular; but it is possible to control the quantity and speed of run-off, very largely by improving the vegetation of the watershed. The smallest flow in the Hudson River has been tripled from its natural minimum. The same methods that bring about a uniform flow also reduce the quantity of silt in a stream. Every one must see that the watersheds of streams are protected by trees and grass. Streams must be made to run with reasonable smoothness, and silt must be reduced. As a good citizen it is every man's duty to conserve as well as to use the nation's water power.

Another means of harnessing water for the production of power has been attempted by the Government in a huge experiment at Passamaquoddy Bay, Maine. The idea was to hitch up the ocean tides and make them develop power as they rise and fall. The unfinished experiment does not show much promise of immediate success. The prospects are, nevertheless, challenging. If an effective means could be discovered, the world would possess an almost endless and never-failing source of power.

Transportation

Another great use of water is for transportation. Throughout the world, this is of very great importance. Transportation by water enabled navigators to discover America, opened up the great Mississippi Basin, and formed the highways for developing a great United States.

River transportation has decreased in importance, but at one time rivers and their tributaries were the only avenues of travel over a vast section of the country. In early times the Mississippi River was the only highway over which settlers in the valley could reach the outside world. Freight floated with the current down the river on rough keel boats and flat boats. The keel boat was a rough but durable barge, being used for more than one trip. When a keel boat arrived in New Orleans it was quickly unloaded, and the arduous task of getting it up stream began. Sometimes the men poled it; sometimes they towed it from the bank; and sometimes they moved it ahead with a windlass. All three ways were hard, and it took many weeks to work their way back to Louisville. The flat boat was more crudely built. After the trip downstream it was torn apart at New Orleans and



Using water for transport when there is little need for speed conserves coal and fuel oil supplies. A load of 6,861 tons of steel.

sold for lumber. The crew returned to Louisville on foot. It took them about five weeks if Indians or pirates did not murder them along the way.

Invention of the steamship greatly stimulated water transportation. In 1820 there were 72 steamers registered on the Mississippi; by 1847 the number had reached 1,200. Shortly after that period, the railroads began to make inroads on river transportation. In a relatively short time the industry almost disappeared. An attempt is now being made through the Government's experimental barge line to re-establish the Mississippi as an avenue of trade by creating a nine-foot navigable channel from the mouth to St. Paul and Minneapolis. The financial success of this venture is still to be demonstrated.

A hundred years ago canal transportation was thought to be the solution of the nation's transportation problem. Projects were suggested that would connect the Pacific with the Atlantic. About 4,000 miles of canals had been constructed before the railroads began to offer serious competition. Of these canals, the Erie Canal is about the only one to survive. As a means of trans-

portation, barge canals have almost entirely disappeared. It is doubtful that they will ever be of importance again.

The emphasis at present is on ship canals. An attempt is being made to enlarge existing channels so that ocean liners can come through the Great Lakes to Duluth. Another project calls for a ship canal across the base of the Florida peninsula, and still another would build an inside passage from New Orleans to Baltimore making use of the existing sounds and supplemented by artificial channels.

Irrigation

Irrigation is still another important use of water. In the world there are about 126 million acres under irrigation. In India alone, 50 million acres have some form of irrigation. The irrigation canal in the Ganges Valley with all its tributaries is almost ten thousand miles long. The largest project in India waters over one and three fourths million acres and supports a population of 800,000. Egypt is a country almost half again as large as Texas, but its 16 million people are crowded into a narrow strip of irrigated country along the Nile. The Aswan Dam, the most important project, is 134 feet high, 6,400 feet long, and impounds 144 billion cubic feet of water, or enough to put a sheet of water one inch deep over 48 million acres. One Egyptian dam just completed is

This striking view taken in Idaho's Boise Valley shows the almost miraculous effect of water on the land. Irrigated land to the right of the canal is fertile and productive; higher, unirrigated land to the left barren except for sage brush. Five million acres in this region are now under irrigation. Grand Coulee Dam will irrigate a million more.

more than three miles long. There were well-developed irrigation systems on the Nile and the Euphrates before Abraham

was born. King Mena, around 4000 B. C., is credited with being the first to use the Nile to irrigate land.

In the United States less than six per cent of the nation's total crop acreage is irrigated. The projects are of two kinds, either complete irrigation or partial. At the beginning, most projects were of the former type and were located in regions of very scant rainfall.

More recently, partial or supplementary irrigation projects are being developed in regions where the rainfall generally is adequate for crop production, but is not distributed through the growing season. During short periods the moisture is insufficient. Irrigation serves to help the crops over these periods of drouth.

A study made of the western part of our country showed that there are 50 million acres of fertile soil that need only water to make them rank with the most productive lands in the nation. The survey also pointed out that the country from which water must come is a difficult one in which to build dams, and one where there are few suitable sites for storage reservoirs. Dams would be so expensive that often only the Government could undertake to build them.

From 1930 to 1940 around 20 major dams were built by the Government. The purposes in building them were credited to control of floods, power, irrigation, water supply, and navigation. The farms that are irrigated by them are sometimes farmed intensively to produce garden and fruit crops, or are used for grazing. Water is sold to farmers at a set price for each acre-foot, and is distributed by means of sluiceways at the time when it is needed. Some farmers distribute the water by means of a sprinkler, but most of it floods on the land through a system of small ditches.

Most of the irrigation projects have been successful. Some have been a source of much trouble. One constant threat which worries engineers is the danger that the storage reservoirs will fill with silt. Hundreds of dams in India have been abandoned for this reason. In slightly more than 30 years, 13 large reservoirs in the Piedmont section of the South have been completely filled with silt. Modern dams have elaborate devices for sluicing out silt, but they are not altogether successful. No one knows for certain how long any reservoir will last.

In two years the reservoir behind this California dam was completely filled with silt.

The only sure method of preventing the accumulation of silt is to prevent washing and erosion on the watersheds. Every effort must be made to keep the protective cover, whether forest or grass, in perfect condition.

Floods

Water can indeed be a true friend, turning the wheels of industry, floating great cargoes, and watering fields; but, uncontrolled, water can be a great enemy. When water is mistreated, it takes out its revenge, washing away precious soil, and silting stream bottoms and dams. On occasion it goes on violent rampages that bring destruction to property and loss of life.

Floods are a great source of worry to men who plan for the wisest use of water.

The disaster that swept the Ohio and Mississippi rivers in 1937 turned public attention to the urgent need for preventing floods. Floods, of course, were a menace long before then. History, modern and ancient, is full of the records of floods that have

Every year small floods are wrecking bridges, undermining roads, and damaging property. Many are too minor for mention in the news and their damages are uncounted.

raised havoc with man and his belongings. Egyptian priests, thousands of years ago, to keep a record of the floods in the Nile, invented the playing cards that we have today. Only afterwards were these cards used for playing games.

Floods under control have been the basis of Egypt's prosperity. If it were not for the silt brought down by the Nile and deposited on the flat country along its banks there would be no city of Cairo. These floods have supported Egypt for centuries.

Every now and then one reads of floods in the badly eroded districts of Eastern China that destroy thousands of people. A single flood of the Yangtze in 1911 drowned 100,000 people, a city the size of Albany.

But we need not go to China for floods. There have been enough disastrous floods here.

In 1889 a dam at Johnstown, Pennsylvania, broke, and the consequent flood drowned more than 200 people and did great

damage to property. During floods that prevailed in the East at the same time the banks of the Chesapeake and Ohio canal were washed out and the canal was emptied in places so that children waded in the pools and caught carp as long as their arms. From the Potomac River, Pennsylvania Avenue in Washington was flooded two feet deep, and the water was so high in the Central Market that a large snapping turtle swam out of a barrel and frightened people out of the market.

In 1927 the flood in the Mississippi River drowned 350 people and did $200,000,000 worth of property damage.

Every year local floods do an untold damage to bridges, fences, mills, and roads; they bury fertile farm lands under deep layers of sterile gravel; they leave coatings of slimy mud that bring disease to men and poison livestock. Their disastrous results are far-reaching, and can not be estimated in terms of money. In the last 25 years, $372,000,000 have been spent for flood control. Yet the flood in 1936 along several eastern rivers is estimated to have cost even more than this, in damage done and in relief necessary to refugees.

The rivers in southeastern United States illustrate what is going on in most of the nation. Rising in the mountains, rivers cut deep channels through the clay soils of the Piedmont Plateau and drop down to the Atlantic coastal plain. The banks are so low on the level coastal plain that the flooding rivers overflow them and deposit their silt along them as they go. Thus rich clay bottom lands are built along the streams until they become higher than any of the surrounding country. The stream bottom builds up as well, until one day the river cuts through the bottom land and runs through the swamp instead.

The Missouri has changed its course so often that the people who dwell along its banks jokingly say that in the morning they are never quite sure what state they are living in until they have looked out the window at the river.

The hundreds of miles of levees that have been constructed during the last century serve their purpose during ordinary years. When the flood overflows the levees they must be built higher. Each new levee adds to the danger of floods elsewhere. The wide channel cut by the floods often becomes too shallow for navigation and wing dams have been built at frequent intervals to

force the old river into a deeper channel. For a time they work at that particular point, but eventually the silt is washed farther down the stream, where it causes more trouble. All the while, unfortunately, the stream bottom continues to fill with silt. Silting of streams increases floods, and floods increase silting and erosion. One condition aggravates the other.

Floods lead to silting. Silting leads to more violent floods. The merry-go-round goes on and on unless men take measures to stop it. The picture shows an Oklahoma river clogging with silt.

The Mississippi River bottom at New Orleans has been building up so steadily that it is now possible to stand on the street and look up at the vessels in the river. Protecting levees can not be raised to an indefinite height and in some places the limit is already almost reached. We have been trying to keep the ever-increasing floods from damaging our property; we are not doing enough to prevent the high water.

Floods are usually the result of a combination of circumstances. Many are caused by the rapid melting of snow in the spring; some by unusually heavy rains; some by the combined

effect of melting snow in one valley and rain in another. The cutting of forests undoubtedly speeds melting of the snow and is to that extent responsible for some floods.

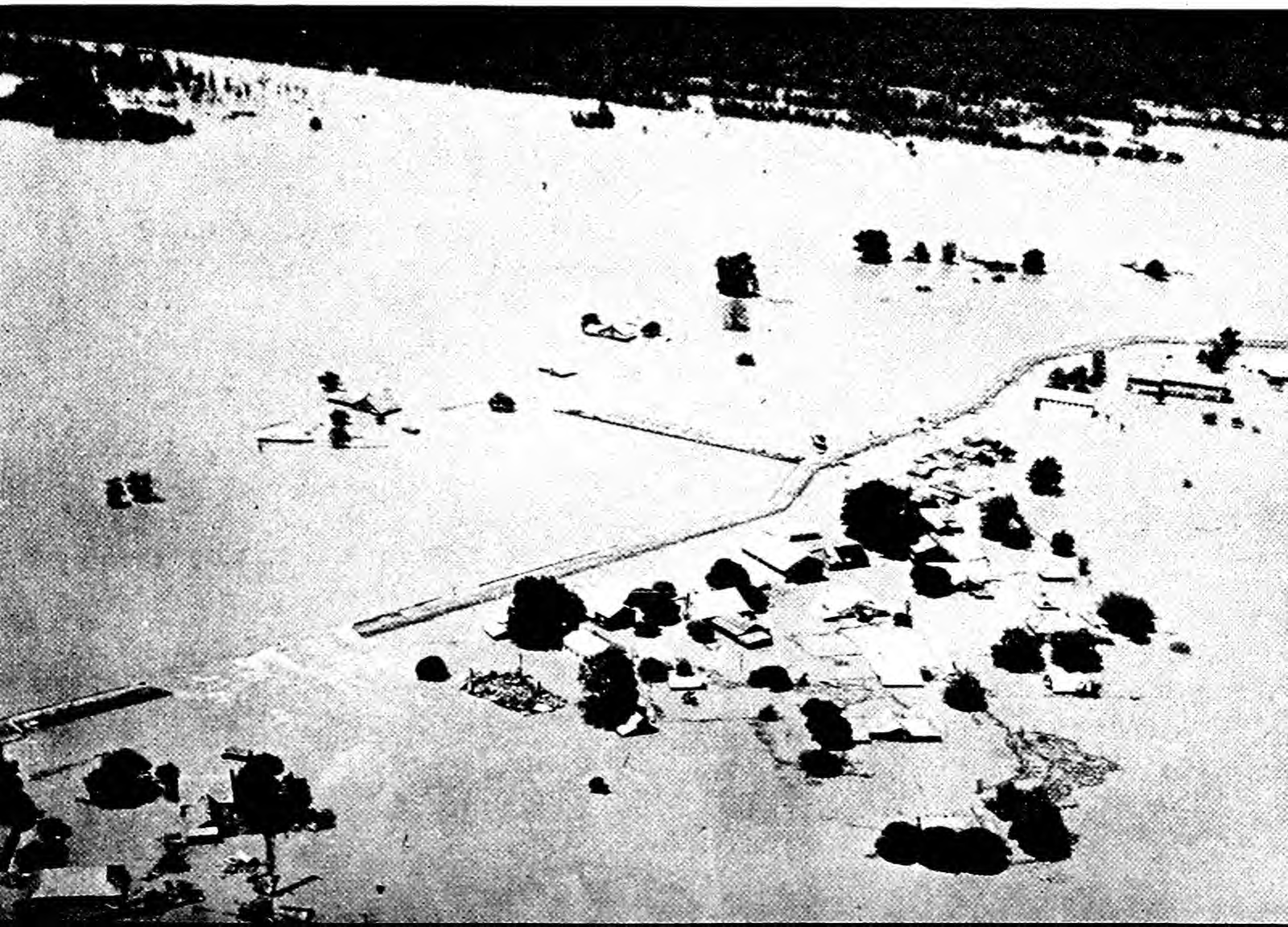
Probably the cultivation of lands is quite as much to blame for floods as the cutting of forests. Anything that speeds run-off to the streams increases floods. We have seen that erosion is probably the most important factor in hustling rainfall into the streams. A stream rising in a forested region shows only a little variation in flow. Its water is largely absorbed by the soil. A stream rising in a cultivated region rises after every rain, and almost dries up between rains.

Seldom is much attention paid a flood unless it does great damage to property, especially in a city or a densely populated farm area. As a matter of fact, damage done yearly by floods about which we never hear amounts to many million dollars.

Three classes of scientists have concentrated their efforts on solving the problem of floods.

The work of the engineer is probably best known. He works with levees to hold the river within its banks; with dams to

Floods are frequently the result of overplowing, overgrazing, and overcutting timber.



A Wisconsin river, choking with mud from its banks, is planted with willow cuttings. After the banks are sloped, poles are laid and held down by wire and posts. Both poles and posts already have long sprouts.

deepen and scour out the channels; with the removal of obstructions to hurry along the flow of water; with digging emergency channels; and with straightening the course of the stream. He puts a high value on artificial storage reservoirs to hold back the flood waters until the channel below is clear. The engineer is able to minimize flood damages, but he must work with the forester and agronomist to prevent floods entirely.

The forester believes that planting all or a part of the watershed to trees will help solve the problem. A forest prevents surface run-off and evens the flow of streams. But it is not always advisable to plant the watershed to forest. For the most profitable use, some of it must be cropped and pastured.

The agronomist plans how farms can be managed so that surface run-off will be small. He plans to crop only the most level land, and keep the steeper hillsides in pasture. Land that is too steep, too rocky, or too infertile to serve any other farm purpose will be kept in forest.

Flood control measures, then, must actually be a co-operative project involving engineers, foresters, and agronomists. Which-

Willows are cut into short lengths and planted between the poles.

The banks are clothed and the stream protected. Cattle are excluded.

ever type of water control you practice will depend upon where along the river you live. Near the source, control by trees and grasses will be most effective; downstream, dams will be necessary to regulate flow.

A steady flow of water is an enormous aid in developing power. During floods, a dam overflows and a large part of the water escapes without doing any work. A flood is often followed by a period of low water when the flow is insufficient to run the turbines. Evenly distributed through the seasons, the very same amount of water might be made to keep a mill running at full capacity all year long.

Conserving the Supply

One phase of water conservation has been given very little consideration. Much of the rain which falls in the interior of the country is drawn from water that has evaporated from the surface or been transpired by the vegetation. If most water that falls runs off at once into the large streams, very little can remain to evaporate or be sent into the atmosphere from the leaves of trees and plants. In regions where rainfall is scant, the absence or presence of trees and ponds of water has a pronounced effect on temperature and precipitation.

On hot summer days, half of the rain that falls evaporates very quickly from the wet ground and from the vegetation. Almost all that remains is absorbed by the soil and temporarily stored to aid growing plants. Once in a great while, rains are heavy and steady enough to soak the ground down to the water table. This ground water must be the basis of our water conservation.

The ground water storage is a truly great reservoir. It holds water without danger of silting, and without losses by evaporation. It must be guarded carefully. When the water table is made to rise, artesian wells and springs will begin to flow. Streams will continue to flow throughout the summer, furnishing water for power and for irrigation.

What can every person do towards conserving the water supply? Most important, perhaps, might be the small dams which are built somewhere along the path which water takes in its hydrologic cycle. The dams might be the roots of grasses which

Running water must be made to walk. Only then can it be best used before reaching the ocean. Small dams of chicken wire and posts are inexpensive and easily built.

Small dams that are both water and soil conservers are being made by modern machines.

Ducks nested the first year after this stock pond was completed on a Texas farm. Every community can have its own fine reservoirs of water.

help to stop the flow. They might be the roots and branches of trees to check the run-off.

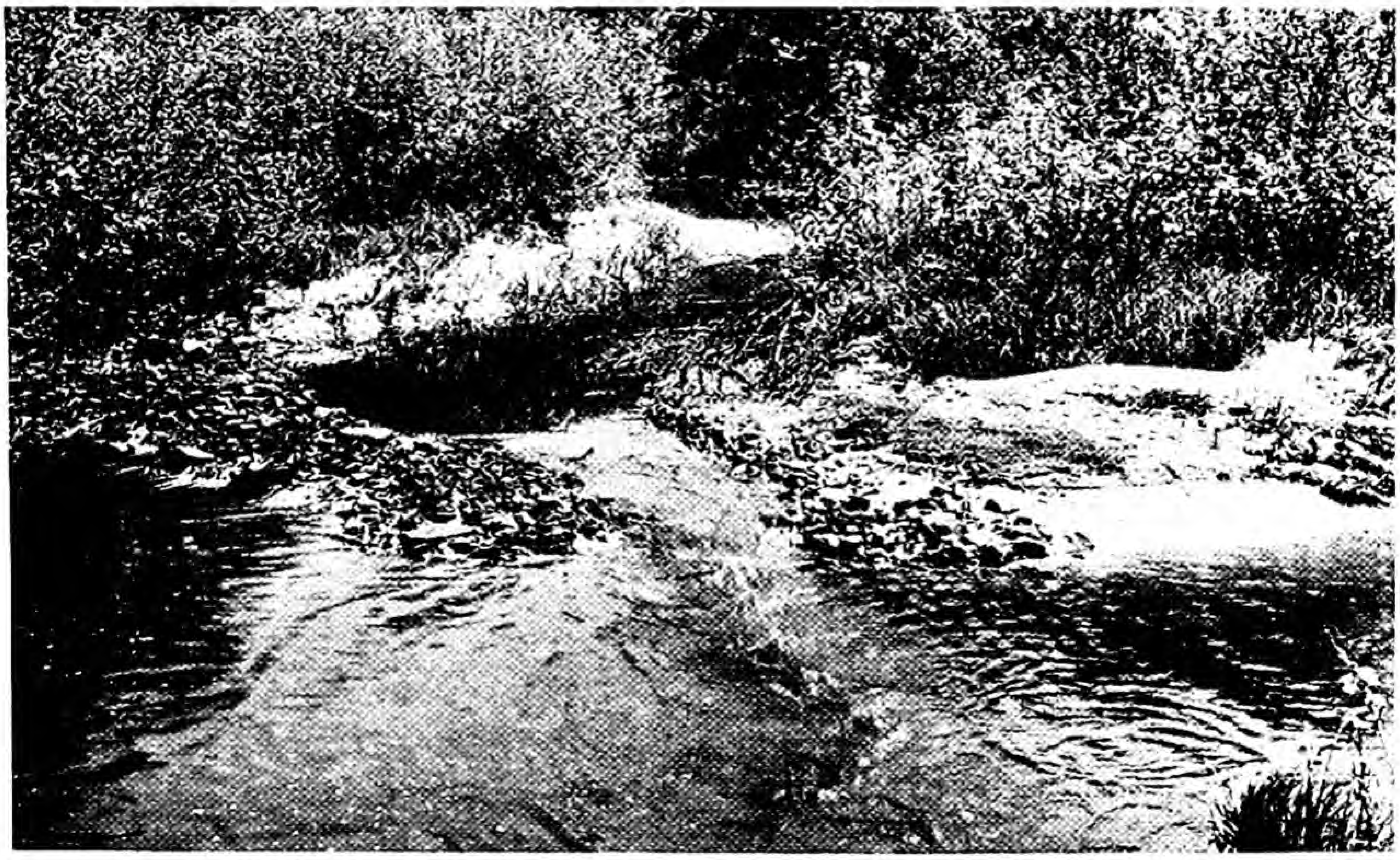
The dams might be those on individual farms to stop the wearing of gullies. They need not be elaborate nor expensive. One of chicken wire and posts will serve to catch the run-off and hold it from speeding downhill. Small ponds of water have provided water for irrigating crops, for watering stock, and for raising fish. In addition, the ponds behind small dams catch the silt before it can destroy the usefulness of large, expensive dams.

Water ought to be put to multiple use. It can provide for human consumption. For such purposes it should be safeguarded from pollution. It can serve the needs of crops, grasses, and forests. For this purpose it ought to be regulated to provide an even flow. Water can provide for fish, and consequently, for recreation. It ought to be kept pure and uniform in flow. Water can provide power for factories and electricity for cities and farms. Finally, it can provide cheap transportation. All at the same time, then, water can serve a number of purposes. The

large Government dams are being constructed to perform several jobs rather than only one.

Sit beside a stream of water some day. Wherever water is running in nature will be a suitable place. Watch the water as it goes by. Is it pure and fresh? If the water is muddy, then somewhere above you, erosion is at work. If it is filled with refuse, then pollution is adding to the ruin of the stream. Is the water running too rapidly and tearing at its banks? Then the stream needs protection. Are there fish in the deep pools? If not, the stream is not in best health. Perhaps silt, pollution, and lack of food are all to blame. There is hardly a stream which can not be improved.

As you watch the water run by, consider how many duties it can perform before reaching the ocean. The more work you can place in its path, the more wisely will water be used. Perhaps you can guide it to irrigate crops. If some remains, perhaps water wheels and turbines can be set in its way. Water will go on unchanged after being used for power. In the wider channels



Deflectors in a stream prevent cutting of the banks. The current formed cuts out a deep pool and keeps the water in motion.

you might make it work all the while until it reaches the ocean. All along the way, water can work for you in growing fish for food and pleasure. If it is kept pure, water will be always fit for human use. Every stream of water can be an interesting problem. In just how many places can water be put to work?

Water might be regarded as an annual crop, depending on the rainfall for its supply. No more can be used each year than falls on the land. But water may be stored for future use—in the ground for years to come, and behind dams for the dry months of the year. How water is stored, kept pure, regulated in flow, and put to many uses will determine how complete is any program of conservation.

Scientists seem well agreed that, if we ever run short of food in this country, it will not be for lack of space or fertility but for lack of water. Every boy and girl, man and woman, must regard it as his moral obligation to do all he can to safeguard the water supply for posterity.

REVIEW QUESTIONS

1. In what places is the value of water most appreciated?
2. For what uses is water particularly important?
3. Trace the path which water takes in the hydrologic cycle.
4. What are the chief types or classes of water? How would you recognize each?
5. Why has pollution been increasing year by year? Name the sources of pollution.
6. What grave dangers attend pollution of streams and lakes?
7. How may pollution be remedied?
8. How has reclamation of swamps and marshes worked great hardship on the human resource?
9. Show how a drop in the water table has caused great disturbances among the other resources.
10. What problems have hampered a quick development of water power?
11. What are the advantages of water power over steam power?
12. What benefits might you expect from greater use of water power?
13. To furnish the most benefits, how should water power be controlled?
14. What conditions must be maintained to protect water power?
15. What kinds of water transportation have been important in American history?
16. Why has irrigation in the United States not been of greater importance than it has? Do you suppose that it will become more common?

Let rain fall in torrents. Trees will soften the fall of water. Grasses will lead it easily into the earth. Contour furrows and dams will make it pause to water fields before passing on. Wildlife will find shelter along the way. And all down its long path the water will run clear and pure.

17. The limit of any dam's usefulness is determined by what condition?
18. Why is each succeeding flood likely to be more dangerous than the one before?
19. Discuss the causes of floods.
20. How do engineers, agronomists, and foresters co-operate to control floods?

SUGGESTED ACTIVITIES

1. Make a survey and map of the water resources in your community. Indicate the depth of the water table at various points. Try to find out what changes have taken place in the water supply.
2. Visit your water supply plant. Study the river or lake from which the water is taken. How much water is used each day in your city or village? What is the possible danger that the supply of drinking water will run low?
3. Plan a program for purifying the water in your community. What persons would you consult? Are the streams and lakes suitable for fish? What sources are polluting the water? Follow the banks of a river, creek, or lake, and observe.
4. Obtain what information you can about sewage disposal plants. Visit one, if possible.

5. Are there drained swamps or marshes which should be returned to their original state? Estimate whether they would prove valuable as storage reservoirs or as homes for wildlife.
6. Look for evidence of a drop in the water table. The shores of lakes, or the banks of rivers may give you a clue.
7. Can you find a near-by location where a fall or current of water might be made to generate power? Could a dam be built? Would it be practical? Plan the possible use that might be made of the power. Where in the United States do you expect to see the greatest development of water power?
8. Could your county be made more productive by irrigation? Where and at what cost could you derive the water?
9. Look up in a file of newspapers the story of one flood of recent years. Has one ever occurred in your locality? Are you in danger? What would you do if a flood should happen?
10. Report to the class on the water-conserving practices of some foreign country.
11. Construct a model of two watersheds—one to illustrate good practice in water-conserving principles, the other to illustrate misuse of water resources. Plant the first one to grass and allow the second to erode.
12. Inspect a near-by dam. Is erosion filling the reservoir with silt? If the water is carrying pollution, outline a remedy.

Debate: The 165-foot drop of water at Niagara Falls attracts thousands of visitors each year If developed for power, it would yield one third the total water power now being used in the nation. Resolved: That Niagara Falls ought to be completely developed for power.

CHAPTER FIVE

Our Forest Wealth

ACCORDING to an old Chippewa legend, a hunter, walking through the forest, stumbled and fell. As he was getting to his feet, he heard a quiet voice behind him. "Human," the voice said, "when you fall you rise to your feet and stand. When we of the forest fall, we never rise again." The hunter turned his head. All he could see was a large tree towering above the others. He knew that a tree had spoken.

With this legend Indians taught their children to respect every tree in the forest. Not one was to be used without purpose, because trees were friends that gave them wood to roast their meat and keep their tepees warm, bark for their canoes, medicine for their illnesses, and shelter for the tribe and the animals that gave them food and skins.

Scanty seem such gifts of the forests, but Indians guarded the trees carefully. The white race, however, drew bounty from the forests that red men did not dream of—poles that would catch and hold great white birds to ships, logs for the bed of a shining monster that was to creep over the plains, and timbers to line deep caverns in the rock. But sadly enough, for all his gifts, the white man gave no thanks or respect to the forest.

Even before men learned how to make the most use of it, the forest was a liberal provider. The giant white pines and spruces of New England made the best ship masts in the world. The British navy ruled the seas for a century because of the tall masts she could get, and the great spread of canvas that her ships could thus carry.

Railroad ties—2,500 of them to a mile—were needed as the infant nation began to grow. When Thomas Jefferson at the start of the nineteenth century looked out across the treeless prairies, he predicted that it would be a thousand years before they were settled. Perhaps he might have been much nearer right, had it not been for the cheap railroad ties that could be cut throughout

Giant forests once covered most of America.

the East. Thousands of miles of track took millions of ties, and they could be made of nothing but wood. Even yet no satisfactory

substitute has been found that will cushion the vibrations of a locomotive as does wood. In the early days of railroad building, white oak ties could be bought for ten cents each.

As men learned how much the forest could offer, they increased their demands upon it.

Except where they cut through hard, supporting rock, the shafts in deep mines had to be lined with heavy timbers to keep them from caving in. The same need prevails today. The forests of the Black Hills of South Dakota cover more than a million acres, but so demanding are the Homestake and other gold mines for supporting timbers that miners object to having any logs shipped out of the hills. Many of Spain's forests have been wiped out to supply timber for the silver mines. Mining in many countries has been handicapped by lack of forests.

The forests of the United States have a huge economic value. In a normal year the products in the form of wood and goods manufactured from wood, exclusive of paper, exceed three billion dollars. Forests have a greater acreage than any other crop.

Roughly speaking, one half of the output of forests takes the form of lumber, one fourth goes into fuel, and the remaining one fourth into posts, wood pulp, railroad ties, and special manufactures. Lumber may be used for such a variety of purposes as roofing, sheathing, and concrete forms, flooring of many types and grades, bevel siding, drop siding, and shiplap, box lumber, ship lumber and finishing lumber, mill work, interior finishing and moldings. These are principally of soft wood.

In addition there are hundreds of other products manufactured from wood: furniture, farm machinery, toys, pianos, radios, scientific instruments, and a great many more. These are manufactured principally out of hardwood such as oak, maple, birch, walnut, mahogany, ash, and hickory.

A forest's greatest commercial use lies in the building stock it yields. Once lumber was so scarce in the old world that only the rich could afford to use it. Even then, their houses were ordinarily made of brick and stone. The poor and middle classes were obliged to rent from the rich, and this practice stimulated the peasant-nobility system with its pitiful serfs. In America the abundance of forests has made lumber so cheap that a great many families have built and own their own homes. There are

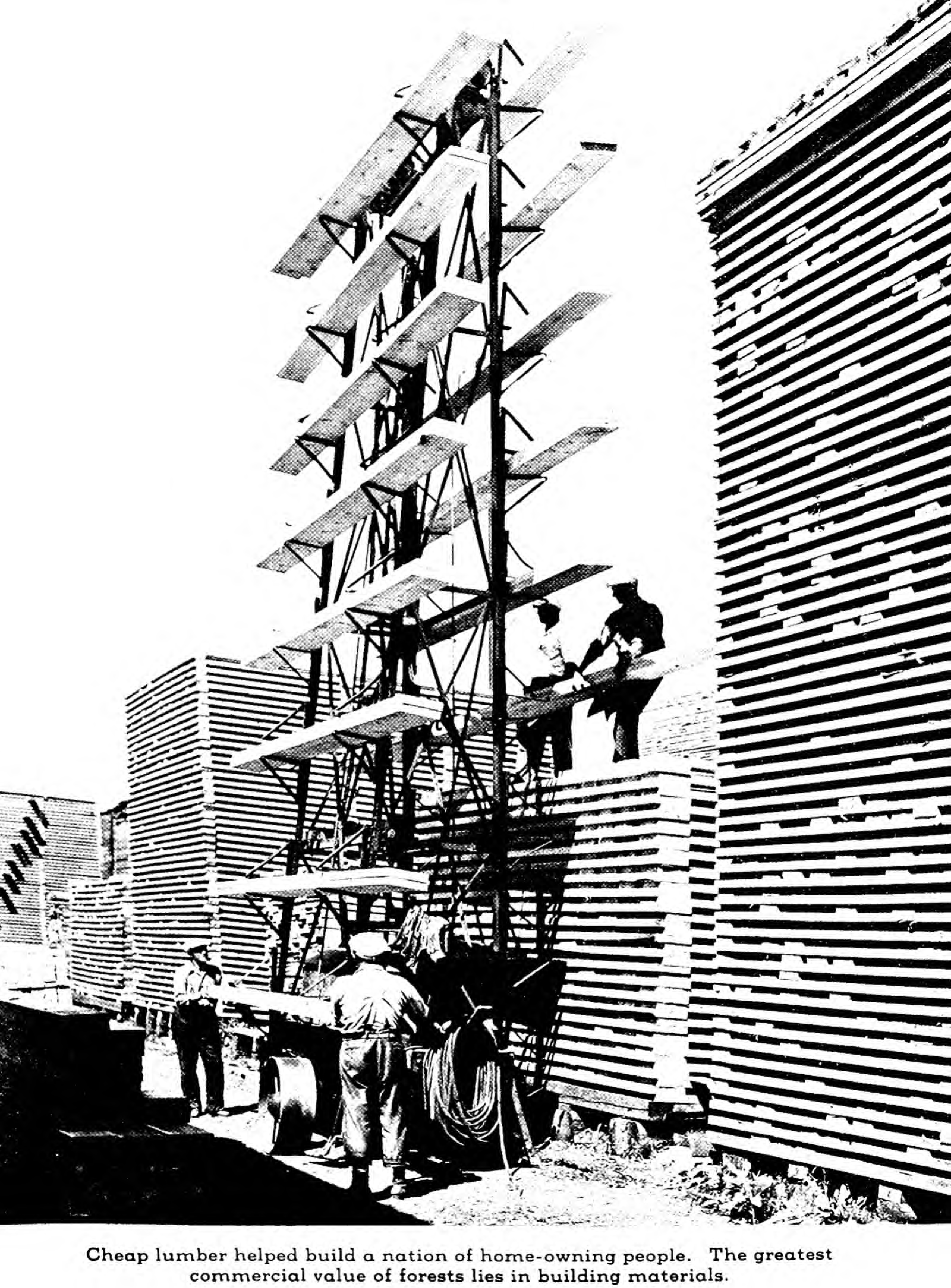
few countries in the world where such a large percentage of people own their own homes. Here, then, is an example of how a plentiful resource helps to preserve a democracy.

Some of the forest's gifts come directly, without need for manufacture. Fruits and nuts provide important types of food. Wildlife finds a home in the dense woods, and furnishes food and recreation at prescribed seasons of the year. About half of the forests supply grazing range for livestock.

Other products of the forest must go through complicated preparation before becoming valuable: paper, rayon, turpentine, rosin, some of the ingredients for movie films, and a great many others. From the bark of such trees as hemlock and oak comes tannin, used to tan leather. In the hard maple country every farm boy knows the joy of tapping trees for the sap and boiling it down into maple sirup and maple sugar. When wood is broken down by sulphuric acid, it yields products that may be changed into alcohol, dye substances, and cellulose. Out of cellulose can be made an almost endless chain of useful articles: lacquers, substitutes for cotton batting, imitation leather, smokeless powder, rugs and carpets, and a clear, colorless substance much stronger than paper, and almost perfect for wrapping food and delicate merchandise.

Besides the direct values of the forests to mankind, indirect uses must not be overlooked. Trees have a very beneficial effect on the soil. Since the beginning of time they have been drawing the elements of fertility from far below the earth's surface, incorporating them into their leaves and twigs, and dropping them every year back upon the ground. Bacteria and fungi act upon the litter of leaves and twigs on the forest floor, decomposing and returning the organic matter to the topsoil and thus slowly enriching the earth's crust. Beneath the litter of partially decayed matter lies rich, mellow humus, more completely decayed vegetable matter. Pioneers knew that, although the forest was hard to clear, its soil was of the richest.

The forest also stands guard over the soil. Its canopy of branches keeps off the beating of the sun, wind, and rain. The rich litter or duff, soft and spongy, absorbs large quantities of water. Every root and tiny rootlet clings to soil particles, holding them in place, and allowing the water to seep slowly through



Cheap lumber helped build a nation of home-owning people. The greatest commercial value of forests lies in building materials.

On the first warm days in spring maple sap begins to run. The sap is boiled to form sirup and sugar.

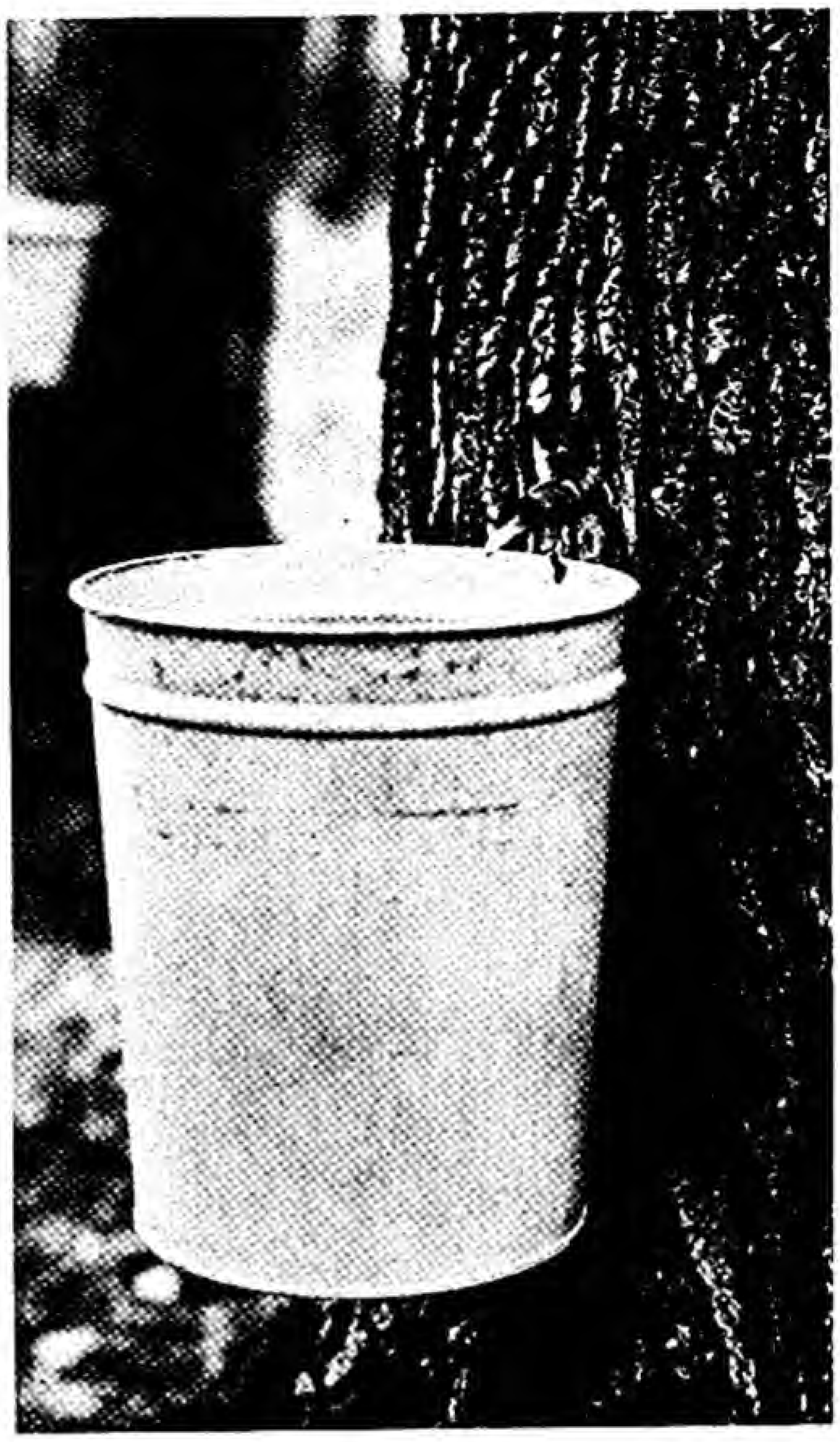
the humus into the subsoil. A square yard of soil in a jack pine forest was carefully examined to a depth of eighteen inches, and one half a cubic yard was found to contain two thirds of a mile of roots. Each root is a waterway that leads the trickles of rain downwards. Water is held in underground storage, making the flow of streams more uniform.

Consequently streams that rise on a forested watershed seldom flood. On barren, treeless slopes, floods are likely to follow heavy rains in a short time. Water seldom is to be seen running over the ground in a forest. No matter how steep the slope, erosion is practically unknown. When soil is kept from washing, streams will be clear, suitable for drinking and for navigation the season long. Forested watersheds help to regulate the supply of water power so that production can continue the year round. Treeless watersheds are almost certain troublemakers.

Not until recent years, when forests have grown scarce, has man come to realize how much a few hours spent in the quiet of

deep woods can do to refresh his tired nerves. The recreational value of the forest today stands high among its uses. Millions of dollars are spent every year by people who desire the pleasure of a few days' relaxation in the forest.

The forest is a community, like a village of many neighbors. Each tree depends upon its neighbor for keeping its roots cool and helping to hold the soil firmly about them. Each tree needs its neighbors for support and protection against wind. Every member of the community, by giving off water vapor, improves the atmosphere for the others.



If carefully tapped, trees will yield year after year without being harmed.

Some trees in the community grow too rapidly and take up too much space, producing large crowns and heavy limbs. These greedy trees are known as "wolf trees," and are harmful to the rest, taking more than their share of water, air, sunlight, and soil. Other trees may be weak, unable to compete, and eventually disappear. Often a forest contains the same species of trees, but just as often it is a mixture of several species. Whether it is pure or mixed depends on how it began.

Besides the trees there are shrubs, herbs, animals, and birds, all living together in harmony with the soil and water, and each depending upon the other for a living.

The hardwood brush in the pine forest helps to keep the soil sweet and productive. The low-growing shrubs help protect the soil from drying by the sun and blowing by the wind. Bacteria and earthworms hasten the decay of fallen leaves and improve the fertility for trees and shrubs, which in turn create fine homes and food for wildlife. Waste from animals and birds adds to the supply of much-needed nitrogen in the soil. In these ways nature promotes a permanent balance.

[illegible] woods relaxes tired nerves.

Growth

Standing by itself, a tree grows a large crown and a stubby tapering trunk. It is often beautiful, but is useful for little else than shade. Let it grow in a dense forest as a useful member of the community, and it becomes valuable. Neighboring trees shade off its lower branches and limit the spread of its crown. The tree in a forest will have a tall, straight stem or bole, practically free of limbs. Lumber from such trees will be of good length with few knots and valuable as building material.

Trees need little to grow: soil, sunlight, heat and water. Soils unfit for farming can often be made to support a forest. Large trees may sometimes be seen growing from crevices in rocks, sending their roots far downward in search of food and moisture. The soil plays a double role in the needs of a tree. It furnishes anchorage for roots besides supplying the necessary chemicals.

Sunlight furnishes the energy for converting food elements into plant tissue. For ordinary growth, any light, whether direct, diffused, or reflected, will serve the purpose. For maturing buds, flowers, and fruits, direct sunlight is needed.

Plant food is composed of minerals that pass from the soil into the roots, and of carbon dioxide taken from the air through pores in the leaf, and combined with water, in the presence of chlorophyll, the green coloring matter of the leaf, to produce glucose (sugar). Plants with green leaves, when exposed to direct sunlight, are stored with energy-producing food substances by a process known as photosynthesis. The glucose constitutes the material from which other plant substances are thus made and go to build the skeleton, reserve foods, protoplasm, and various secretions. This storage by the tree of food for itself results ultimately in a storage of food for man.

Thus the forest ministers to its own life and growth, it retains rainfall, lessens the chances of floods, prevents erosion, and from year to year fertilizes the soil which nourishes it. In the future men will undoubtedly think less of its relative importance as building material, and more and more of the ever-mounting significance of its water-holding and soil-holding ability, its part in the balance it maintains in nature, and, in general, its resource-regulating effect upon itself and the welfare of mankind.

Soil and sunlight would be of small value without water. The food elements can be taken into the roots only in a solution. They are carried in solution from the roots up the trunk and into the leaves. Water also supplies the oxygen which is combined with the carbon from the air. The transpiration or evaporation of water from the leaves supplies most of the energy that lifts the sap from the roots to the crown. The quantity of water a tree

The forest floor is rich in fertility.

transpires is very great. Forests are nature's air-conditioners. The water as it evaporates from the leaves has a cooling effect on the climate.

From its beginning as a seed, a tree undergoes strange processes, some of them known to foresters, and others not yet fully understood. Buried in the soil, the seed absorbs water, swells, and begins to grow. A small root is sent downward, and a stem grows upward according to the mysterious laws of plant growth. Leaves are formed on the end of the stem to capture light and put it to work. Root hairs form on the ends of larger roots to draw in water and food.

By the end of the first year a group of buds has formed at

the end of the stem, and a thin layer of live tissue, known as the cambium, has formed a coating over the entire plant just under the bark. The cambium is the important growing part of a tree. When stupid persons strip the white bark off the birch tree, they are killing it by exposing the cambium.

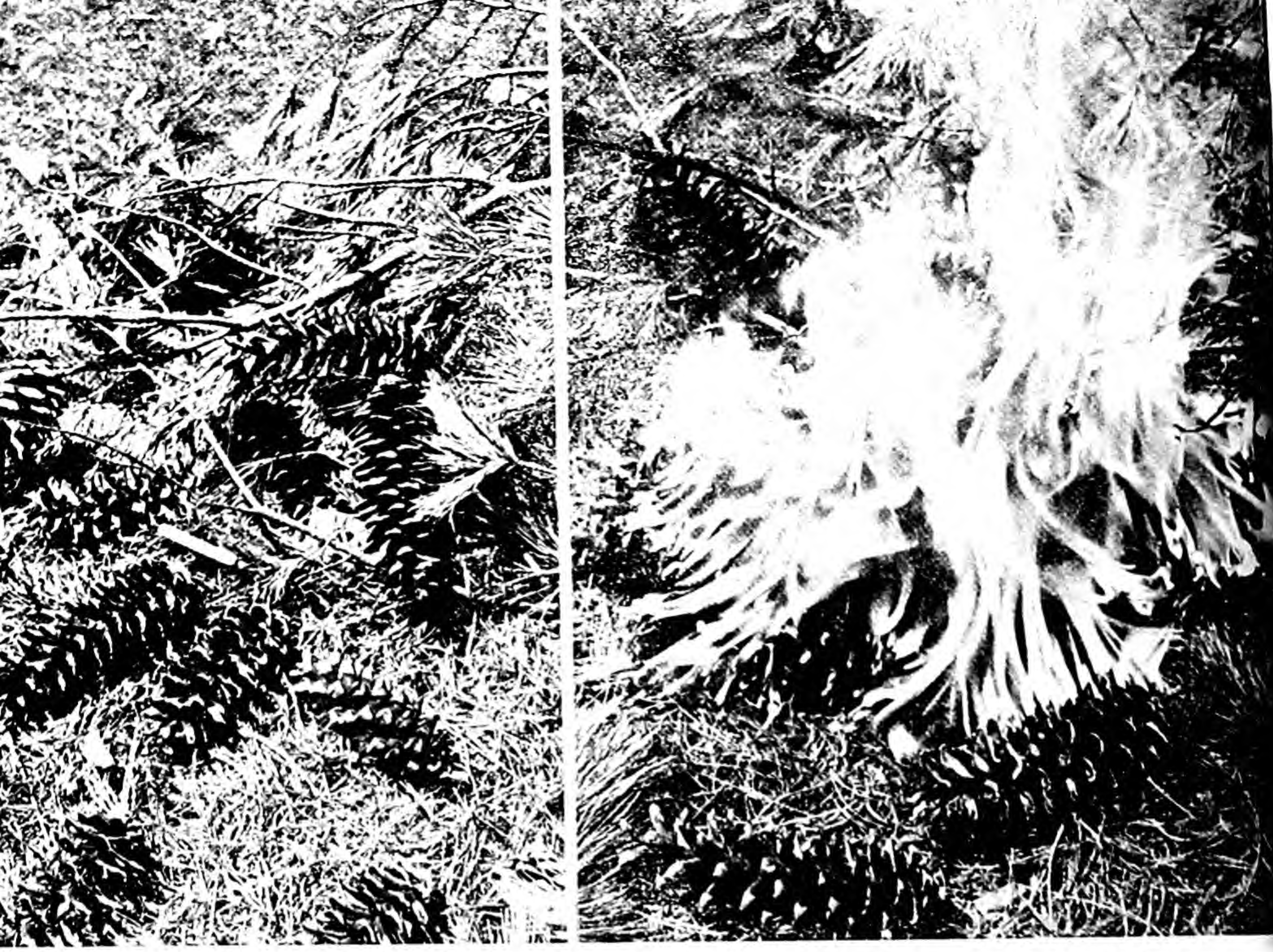
In the spring the bud, carefully protected with a tough covering through the winter, opens and starts to grow. It seems remarkable that the small bud knows how to grow, but under a microscope can be seen in miniature in the bud every part of the tree that will form during the coming season, including all the leaves and flowers in their exact number. Should the buds be injured by fire or frost, growth may be seriously checked and the tree may die.

As long as a tree lives, it grows in three directions: downward by the roots, in length from the buds on twigs, and in diameter by the growth of the cambium layer. A limb that forms two feet from the ground can not possibly grow to be any higher on the tree than that point.

Cambium has the peculiar habit of growing in two ways. On the inside it forms wood, and on the outside, bark. In the spring, the cells that it forms are thin-walled and light-colored; as the season advances they become thick-walled and dark. Each year a new circle of dark and light wood is formed that is called an annual ring. By counting the rings on the cross section of a log, it is possible to tell the age of a tree. The number of rings that has grown over a fire scar tells the date of fires that occurred long before the white man came to this country.

The giant redwoods of California are probably the oldest and largest living things in the world. It is fun to count back on the rings of the stumps to find how old they were when the Declaration of Independence was signed, when Columbus landed in America, when Christ was born, or when the Chinese first discovered the use of gunpowder. Some of these redwoods are three thousand years old. Many of our common forest trees are three hundred or more.

In the forests of the rainy tropics, trees grow the year around, and no annual rings form. It is impossible to tell their ages. All cells that form are thick-walled. Some tropical woods like rosewood are consequently so heavy that they will not float.



The larger the forest, the drier the air, the higher the wind, the bigger the fool, the bigger the fire you will have. Ninety per cent of forest fires are man-made, and many result from careless smoking.

Devastation by Fire

And yet, these forests, which have taken centuries to grow, are destroyed by their worst enemy, fire, in a few minutes. No other resource is destroyed so completely or so quickly. Raging [illegible] tops or blazing along the ground, fires have con- [illegible] in the United States than has been cut for [illegible] still burn over an area the size of the state of Colorado. As a calamity, great fires are said to rank with floods, pestilence, famine and earthquakes.

As fire races through the forest, often at express-train speed, it roasts the seeds that should replant the barren acres, kills every seedling and reduces the rich duff and litter to ashes. Often the [illegible] forest soil, centuries old, is so badly damaged that it can

There are three classes of fire: ground, surface, and crown. The first two can be smothered out with water or earth, but crown fires such as this one at Malibu, California, are often impossible to control.

grow nothing but weeds. The finest tree in the woods can not save itself from the hot blast. Many are withered and fall before the first heavy wind. Rabbits, foxes, fur-bearers and other animals must flee for their lives. It is said that during a fire some people who took refuge in a wet meadow found beside them six bear, eight deer, and a lynx. Even deer, fleetest of forest creatures, are caught; as many as eleven carcasses were found in one spot. After the fire, not even the chatter of a squirrel nor the whisper of stirring branches breaks the silence of the charred ruins. Rain leaching through the ash produces a lye that often kills fish. The eggs of birds are cooked.

"To stage a forest fire," wrote Guthrie of the Forest Service, "you need only a few things—a forest, the right atmospheric conditions, and a spark, either from a lightning bolt or a match in

the hands of a fool or a knave. The formula is simple and the wonder is that we do not have more and bigger fires. The larger the forest, the drier the air, the bigger the fool, the bigger the fire you will have."

Our climate has furnished the forests and the proper atmospheric conditions, and the white man, it seems, has furnished the fools in countless numbers. Man with his smoking, his land clearing, his logging, and his picnicking has started hundreds of thousands of forest fires. Building a campfire is great sport, but digging down the coals, getting water from the creek to wet them down, or stamping out the remains too often is thought of as a chore. Sparks from locomotives have caused many fires.

Really dangerous blazes require three conditions: prolonged drouth, low humidity, and a high wind. In the Northwest and Lake states, these conditions are usually found in the fall. In the Middle Atlantic states most fires occur in the spring and fall. In the Central states, fires are most active in the spring. During the dry winter months, fires are likely to break out in the

Raging fires like this one in Oregon have destroyed more timber in the United States than has been cut for use. An area the size of Colorado is burned over each year.

Forest death in Idaho. Seeds are roasted and wildlife killed. Even the soil is dead when the humus has gone up in smoke. Only a few sparse weeds grow on these idle acres.

South. A fire may be one of three kinds: a crown fire, that most often occurs on a steep uphill grade and in pine forests; a ground fire, that burns through the peat, leaf mold, and humus; a surface fire, that burns grass, brush, slash, and young trees. The last is by far the most common. The acreage covered by these fires is enormous. Many years of time and dollars of value are lost.

Fires have written their own histories on the trunks and annual rings of trees. California's giant redwoods bear the scars of fires as far back as the year 245. In 1441, in 1580, and again in 1797, others marked their date in the annual rings.

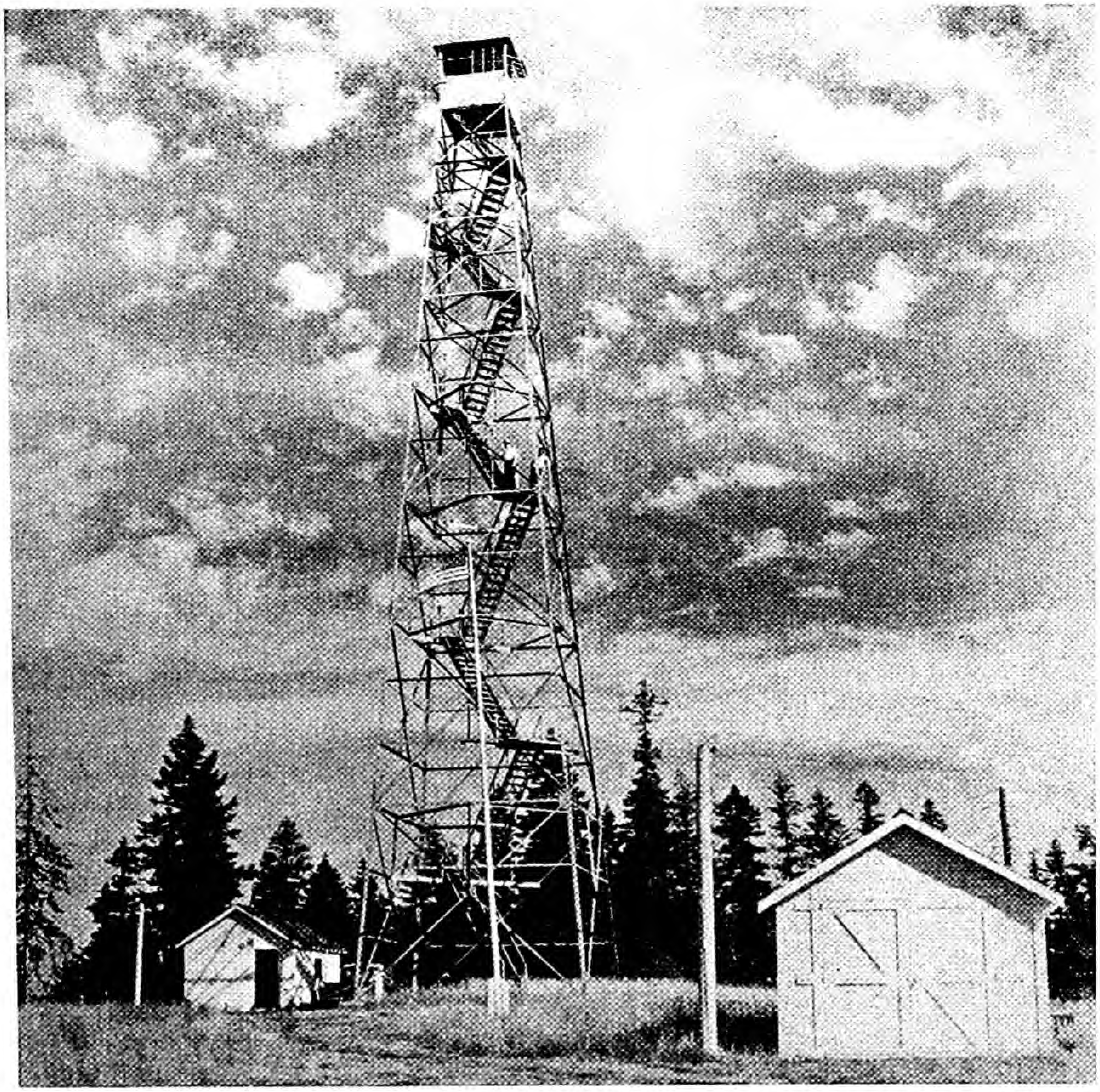
In 1825 the great Miramichi fire in Maine and New Brunswick burned over 3,000,000 acres and killed 160 people. In 1871 the Peshtigo fire in Wisconsin, probably the worst fire in Ameri-

Bare mountains in Arizona are ready to erode and overrun the valley with silt and floods. Many of the remaining trees have been injured and are an easy prey to wind, insects, and disease.

can history, burned over 1,250,000 acres, sweeping over whole towns and burning over 1,500 people to death.

In 1894 the Phillips fire in Wisconsin and the Hinckley fire in Minnesota together burned over a quarter of a million acres, destroyed a dozen towns, and killed over 900 people. The year 1910 was the driest in history. There were terribly destructive fires all over the Northwest. In Minnesota 300,000 acres were destroyed and 42 lives lost. Washington and Oregon had tremendous fires extending over vast areas. The smoke was so great that nautical operations were interfered with for miles out at sea. Near Wallace, Idaho, an area 120 miles long and from 25 to 35 miles wide was burned in two days, and 74 men lost their lives.

While war was being fought abroad in 1918, a forest fire suddenly descended upon the city of Cloquet, Minnesota. Through



Towers are the eyes of the forest service. Smokes can at times be located as far as twenty miles away. From sunrise to sunset lookout men are on constant watch.

the courageous work of a forest ranger and a railroad station agent, 8,000 inhabitants were removed safely. The town was destroyed in a few minutes. Many who fled in cars were lost in the smoke and burned to death. Over 400 people lost their lives.

These are only a few of the great fires that have charred the pages of forest history. It is safe to say that at least 90 per cent were man-made, and most of these were the product of carelessness. A match carelessly thrown by the roadside, a cigarette

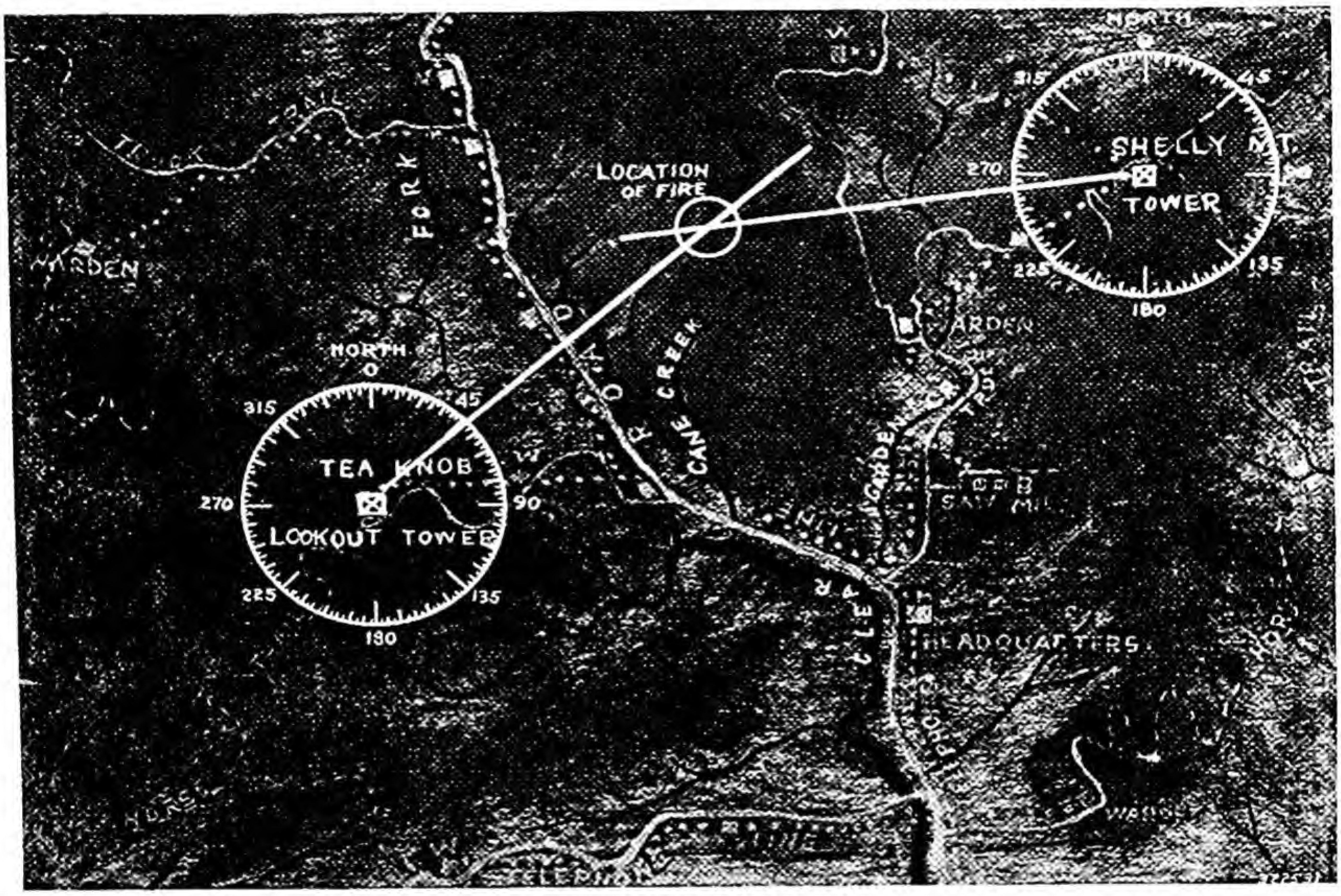
dropped in dry leaves, campfires not completely out—anyone can be the start of the forest's red enemy. In the East, it is estimated that 50 per cent of the forest fires are caused by smokers.

Once a fire is started, it must first be located. The most com-

The lookout man moves the alidade until it points directly at the smoke, makes a note of the direction, and calls the nearest ranger station. Usually another lookout has sighted the fire and telephoned in, giving the direction from his tower.

mon method is through use of the lookout station, usually placed on a high hill and manned throughout the dangerous season. Each tower man, or lookout, is equipped with a map of the country that he can see, with field glasses, a compass, a telephone, and a movable bar or alidade. When a lookout "spots a smoke," he sights along the top of the alidade, notices the direction of the

fire from his compass, and telephones a report to the ranger, who marks the direction on his map and gets a like report from a second tower. Where the two lines cross must mark the location of the fire. The size of the fire is estimated and a crew collected, together with provisions, axes, and pumps. The pumps may be large ones that are set up on the bank of a stream or lake, smaller ones to pump from the tank on a truck, or small "trombone" hand pumps to pump water from a canvas packsack.



On a map of the country the forest ranger lays out the directions given him. The fire will be found where the two lines cross. Locating fires is of utmost importance in hurrying men and equipment to the scene.

Fires can be smothered out by covering them with soil, or drowning them with water. Ditches to stop their spread are ordinarily effective. When the wood and leaves are removed from the path, the fire may die.

Costly as locating and fighting forest fires may be, when compared with fire control in a large city, it is seen that the expense is relatively small. One city that covers an area ten miles square spends a million dollars a year on its fire department. There are

almost half a million people in the city ready to report any sign of fire. The forestry service in that state can spend only a quarter of a million dollars to protect 33,000,000 acres. The Forest Service, in spite of its good record in stamping out fires, is in great need of more equipment and men.

Pests and Diseases

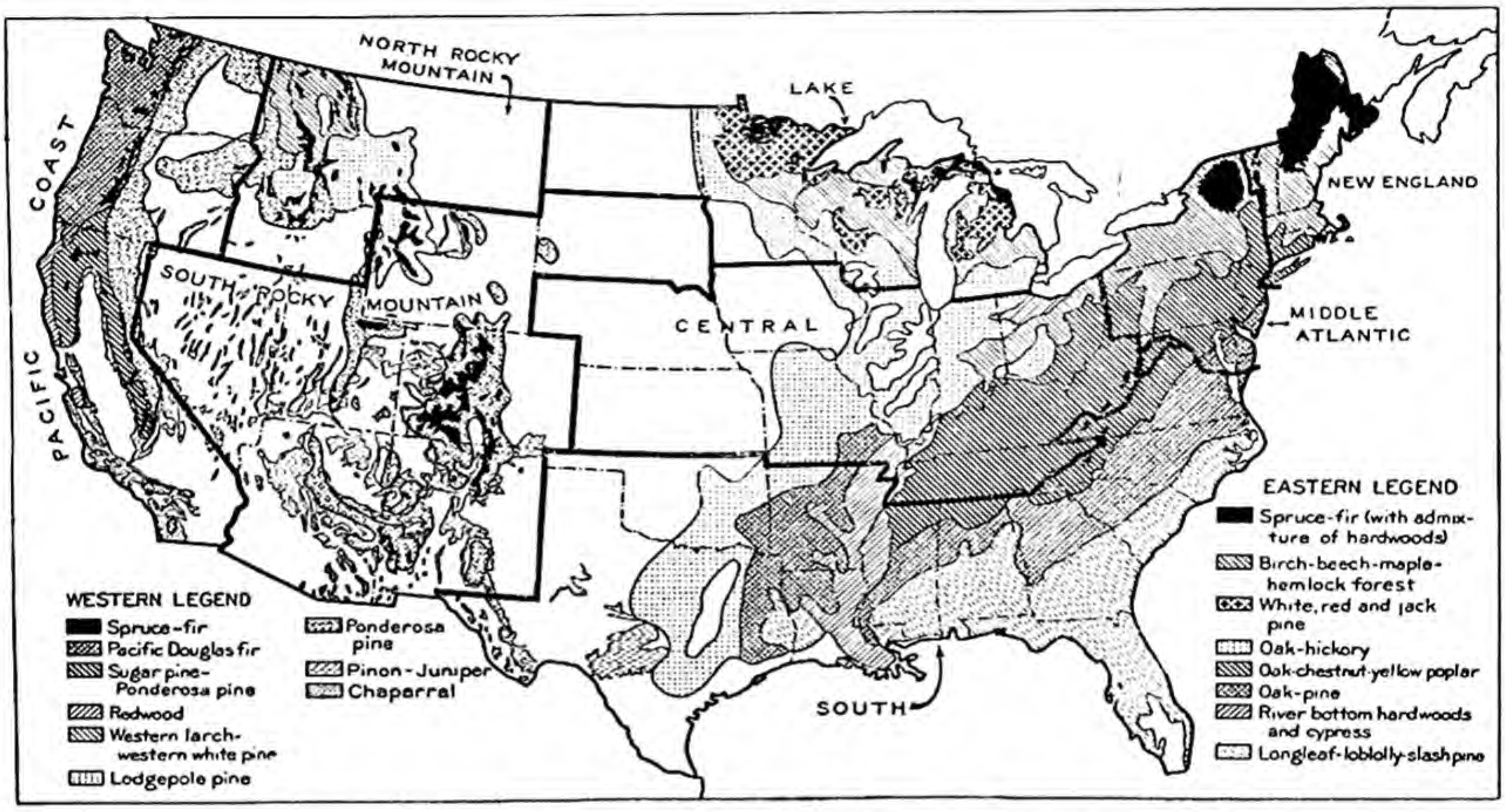
Fire is a spectacular enemy of the forest that performs its evil quickly and completely. But there are other enemies besides fire quietly working their damage. Bark beetles are almost constantly attacking trees, particularly those that have been weakened by fire or drouth. When the tree is vigorous, it sends out sap or pitch to imprison the insect and heal the wound. If it is ailing, the young larvae of the insect burrow their way into the bark and soon kill it. Others may attack the root, leaf, or trunk.

The tamarack of the Lake states in 1915 and 1916 was all but eliminated by the larch sawfly. Every now and then, conditions may be right for a certain kind of insect to build up in sufficient numbers to menace a forest. Introducing parasites that prey upon the harmful borers, beetles, and moths has often proven effective. The woodpecker and nuthatch families give good protection. Spraying trees gives some aid.

Diseases, too, attack trees. Most of them are caused by parasites known as fungi. Most of the worst diseases are those brought in from other countries. Native trees have apparently developed a resistance to native diseases, but have no type of immunity for foreign ailments. Chestnut blight, introduced from Asia, threatens to destroy the chestnut trees in the East. Those left seem doomed, since no means of checking the trouble has been found. The white pine blister rust, brought here from Europe, is a most serious disease, but it does have a point where it may be attacked. It can not spread from one tree to the next without first passing through a stage of its life on currant and gooseberry bushes. From these bushes it spreads to pines. When all currants and gooseberries are removed in the neighborhood of white pine, the disease is checked. The Dutch elm disease, also imported from Europe, is threatening vast areas. Forest conservationists, then, must be doctors to the sick and infected trees. Great care must be taken to keep out foreign diseases.

The Damage Has Been Great

The wanton cutting and burning of forests has destroyed much of the original forests of America. Once almost half of our country was covered with valuable forests—vast areas as large as all Germany, France, Spain, Italy, Norway, and Sweden put together. No country in the world had ever been so blessed with



The type of forest depends upon rainfall, climate, and soil.

usable trees. In the Northeast and Lake states, spruce, pine, and valuable hardwood forests stretched from Maine to Minnesota. Over all, white pine was king. In the eastern part, forests of beech, birch, maple, and hemlock were common. In the eastern central part of the United States grew fine forests of oak, hickory, yellow poplar, and black walnut. In the uplands of the South were magnificent stands of longleaf, shortleaf, loblolly, and slash pine. In the river bottoms were cypress, tupelo, red gum, ash, and other hardwoods.

The Rocky Mountain forests contained great reaches of lodgepole and ponderosa pine, with much Douglas fir and spruce. In the northern Rockies were towering white pine in mixture with western larch, red cedar, fir, and hemlock. In the Pacific Coast forests were the grandest trees of all, the age-old redwood

Hardwood forests covered much of the eastern half of America. **The trees here belong to a community forest in Pennsylvania and are worth up to $10 each.**

and sugar pine of California. Here, too, grew Douglas fir, Engelmann spruce, cedar, and hemlock. Along streams in the prairies grew other important forests. Pine forests in the Southwest and other trees in the Ozarks were valuable.

Today, less than a quarter of the country is forest, and much of that quarter has been so mistreated that it has little value. For more than 200 years the axe and saw and fire were never at rest. Land, whether or not it was suitable for farming, was cleared of its trees. Few persons realized that land had other uses than for agriculture. Destruction was no less complete even when the land was not wanted. Loggers took only the best timber, and fire inevitably took all the rest.

The famous northern white pine, which supplied almost all the softwood lumber until 1850, and the equally famous southern pine, which has supplied a large part of the eastern market until 1930, are now both practically exhausted. The bulk of the timber supply for America must come largely from the Douglas fir and other trees of the Pacific coast.

The idle, cut-over lands of the nation have increased to almost 200,000,000 acres. From Florida to Maine and westward to the Pacific are naked hills and plains as bare as a floor, stretching as far as the eye can see. Seventeen per cent of our forests are non-productive. That is a national disgrace.

Dangerous results have followed destruction of the forests. The same disastrous effects of cutting protective forests on the mountain slopes in France and in the eastern highlands of China are beginning to be noticed here. The twin evils, erosion and floods, have caused untold damage in the Mississippi basin. The homes of many game animals have been destroyed, and America has lost much of the scenic value the forests provided.

Forest Conservation

All the while forests were being destroyed, there were only a few men in Colonial times with vision enough to see that trees should be conserved. True, the "broad arrow" of the king had marked certain trees to be left as masts for his navy, but this was hardly conservation. William Penn was perhaps the first to appreciate forest conservation. He required in 1661 that for every five acres cleared by a settler one acre must be left in trees.

The beginning of the conservation movement in forestry is more important than any other because it was the first to begin the whole thought of wise use of natural wealth. The thought of conservation began when many Americans visited Europe and were impressed by the care taken of forests in the mother countries. They saw trees so completely utilized that nothing was left in the woods but a hole in the ground. They saw forests replanted immediately after old forests had been cut. They saw that no land was allowed to lie idle. When they returned to this country, they saw with new eyes the barren, burned-over, cut-over lands they had left. Here no attempts were made to halt forest fires or start young forests growing.

When the movement for forest conservation began, about half of our forests had been destroyed and 100,000,000 acres of cut-over land lay idle. Of that timber left, about 65 per cent lay west of the Rockies, while most of the population was still east of the Alleghenies. Getting lumber to market meant a long freight haul that added greatly to the costs.

Carl Schurz, as Secretary of the Interior, began the forest conservation movement, but his efforts largely failed through lack of interest by the public. When Dr. Franklin B. Hough, the "Father of American Forestry," was named in 1876 a forest agent in the Department of Agriculture to study forest conditions, conservation work began. He preached conservation untiringly. Arbor Day, first proclaimed by Governor Morton of Nebraska in 1872, had prepared the public interest. Prairie states offered bonuses to encourage tree planting; others offered freedom from taxation on all forested plantations. A national society, the American Forestry Association, now numbering more than 15,000 members, was founded in Philadelphia in 1876, and the first state forestry association was organized in Minnesota in the same year. Cornell University in 1896 introduced forestry courses.

The fate of forests hung by a slender string when, on the last day of the 1891 session of Congress, a bill was debated as the last minutes ticked away before closing. The clock had been turned back until the bill was passed. In the confusion of the last few minutes, a "rider" that was attached to the bill slipped through unnoticed. The bill has long since been forgotten, but the rider scored a victory. It gave the President authority to set aside

The forests were cut without thought of the young timber that might have grown to replace the old. This Michigan hardwood forest might have yielded a heavy second cutting had care been taken in logging.

land from the public domain to be designated as National Forest Reserves. For fear lest people might think the forests were to be hoarded without use, the name "reserve" was, in 1907, changed to National Forests.

President Harrison was the first to use the new law. In 1892 no one objected when he set aside a tract of land adjacent to Yellowstone National Park. But after President Cleveland designated 15,000,000 acres as national forest, Congress talked of repealing the law.

President Theodore Roosevelt and Gifford Pinchot, Chief of the Bureau of Forestry, were two men who gave great aid to the practical war on forest depletion. They used to talk during their afternoon tennis games back of the White House about the problems of conserving forests. In 1905 they enlarged the scope of the Forestry Bureau, renamed it the Forest Service, and transferred the National Forest Reserves from the Interior Department to the control of the Forest Service. Tremendous opposition immediately developed when stockmen, who for years had been

using the forests for summer pasture, were denied entry. Pinchot established a grazing fee and soon they discovered that orderly use of the forests for cattle had real advantages.

The acquisition of forest land by state and Federal agencies is the most important step in forest conservation that this country has taken. At present there are about 160 national forests, averaging more than a million acres each. More than 30 million people visit them each year. Many states, too, have established forests of their own. There are still millions of acres of public domain that ought to be in national forests.

One of the finest aids to forest conservation has been the Civilian Conservation Corps, established in 1933 to offer unemployed young men work in conserving forestry, soil, water, and wildlife resources. In fire control, the speed and energy with which they attack their work have kept fires to a minimum. They are building hundreds of miles of truck trails which make spots once removed by two or three hours' travel accessible in a few minutes. Roadside rubbish that might have been a dangerous fire hazard has been cleared. In the short span of its existence, the CCC has planted immense tracts of barren land to trees which in time will provide needed crops of wood. Workers have released valuable young timber from the competition of less valuable species. Much young timber has been thinned so that the remaining trees may grow more quickly. In addition, war has been declared upon the insects and diseases of trees. Dams and terraces have been built for water and soil conservation. Conditions for wildlife have been improved.

Not only the nation has benefited, but also the young men who have carried out the program. They have been taught valuable lessons in stopping waste. Very likely the activity will become a permanent one.

Various other organizations have contributed much to the cause of forest conservation. Some already have lent years of service. The American Forestry Association has been helpful in educating the public to forest needs. The American Tree Association and the Society of American Foresters have been strong supporters of forestry. In addition to these national groups, there are state societies that are important in shaping public interest and promoting the passage of adequate laws.

When fallen trees are used at once the logs will not be damaged by moisture, bark beetles, and other insects. Dead and down timber is a fire trap. Scene in the White Mountain National Forest, New Hampshire, shows the work that must be done following a heavy windstorm. National forests have pointed the way for management of private forests.

But waste is not a story that belongs to the past alone. Even though the conservation movement began in forestry and has been supported by fine leaders and organizations, unwise use of the forests is still going on. America is still guilty of shameful misuse of its forests.

Preventing Wastes

What are some of the wasteful practices that conservationists must be on guard to recognize? Sawyers still leave up to a third of the best wood in the tree as a stump. In most of Europe trees are cut at the ground level. At times even the roots are cut and the tree pulled over. The bole then can be cut off below the ground and even the roots used.

The great forests were cut and logs were floated downstream to the mills. Sometimes a log jam blocked the river.

If a log becomes jammed between rocks or standing trees so that it is hard to move, it is often allowed to remain. Trees are allowed to break as they fall. In a study made of two crews, the inexperienced men broke 33 per cent of the trees they felled. The experienced men broke only 3 per cent. Too many logs are still being cut in even lengths only. If a log is 15 feet, 11 inches long, the lumber from it is cut down to 14 feet, simply because carpenters do not like to use lumber of odd lengths. Americans are accustomed to using only wide boards and regular lengths in building. A top below eight inches is left as waste. Hardwood tops of eighteen inches are often left.

After the logs have been brought to the sawmill and factory, there is still further waste. As a result of carelessness all along the way, it has been estimated that not more than one third of the tree is really utilized. We can well blush with shame to think that in parts of Europe as high as 97 per cent of the tree is used.

Great as the losses are in handling the timber that is sold, there is an even more serious waste in the forest. The young trees that should grow into a crop for the following generation are crushed by trees that are carelessly felled. The saplings which escape this danger are ordinarily killed by the logging operations that follow—skidding and hauling. Thrifty young trees are sometimes used to corduroy swamps where a worthless species might serve as well. Fire is encouraged to burn up the slash left by the logging job. The young timber is burned black. This is horrible waste. Black-scarred, barren wastelands are still too frequently the trade-mark of American stupidity.

America must put an end to forest waste. The better logging concerns have already pointed the way that conservation must lead. In winter logging, the snow is first shoveled away from the tree trunk and the stumps are cut low. Logs are cut into the

Cut-over, burned-over, and forgotten, almost 200 million acres of once valuable forest land now lie idle. This is a national disgrace. Here is Minnesota cut-over land, burned more than ten years before.

tops to a diameter as small as five inches. Contracts usually specify the species of trees that can be used for skids and for corduroying roads. Where there is a suitable market, the tops of logged trees are cut up into cordwood and sold.

In the sawmill there has been considerable progress. In the seventeenth century mill, the saw was stretched between two beams that moved up and down once with every revolution of the water wheel which powered it. Since saws could not be stretched tightly, they had to be thick. Thick saws cut a wide kerf, or slit. For every inch board that was sawed off, almost half an inch was chewed up into sawdust. With good luck, one of these mills would saw from one to three thousand feet of lumber in a summer's day. Until the steam engine was invented, no power was fast enough to turn a circular saw.

When steam was applied, the centrifugal force at high speeds became so great that saws flew to pieces. Finally with a stronger steel saw and a 90-foot rim speed per second, the kerf was reduced to a quarter-inch. The band saw, an endless ribbon of steel with teeth on one edge and stretched very tightly over two large wheels allows a very thin blade, and the kerf is reduced to an eighth of an inch. Small saws now do all the work except cutting the original log into large dimensions. They effect a saving in wood as well as in time.

Uses of Wood

Other economies must be introduced more widely. The "edgings" trimmed from boards ought to be sorted and cut into moldings. Short pieces should be made into lath and box boards. Much of the waste ought to be saved for fuel. Until good use can be made of the mountains of sawdust which surround mills, it can not be said that forest products are truly conserved. Early in 1940 came word that a process was being perfected for converting sawdust, slabs, and tops into coke. Its success would mean tremendous progress in stopping forest wastes.

Any conservation study must look to the great uses of a resource to find how better methods might effect a saving.

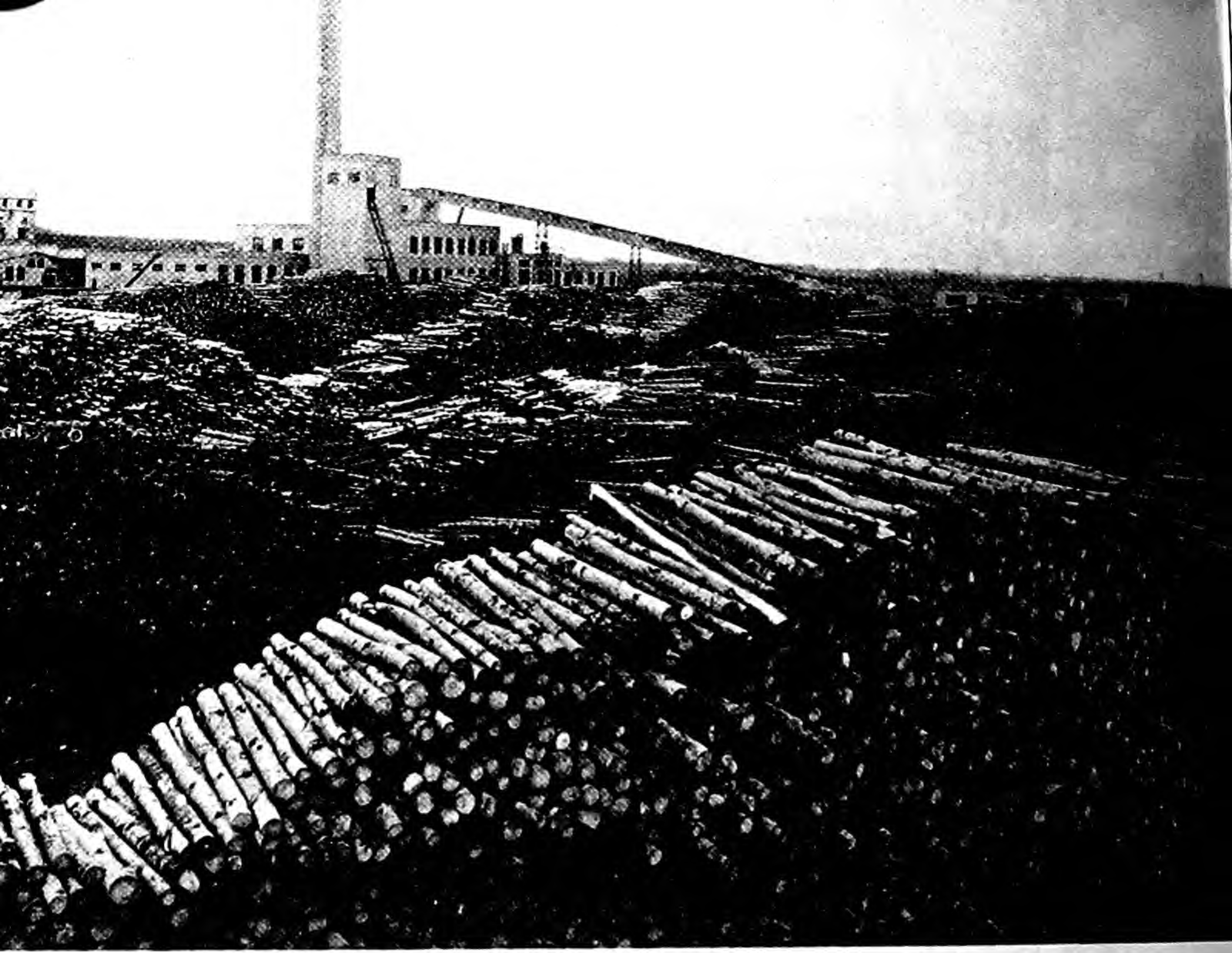
The constantly growing call for paper is draining the forest supplies over many areas. More paper for newspapers, for magazines, for books, and for wrapping paper is America's cry.

Bark, sawdust, and other wastes must be widely used before conservation can be considered complete. Paper, building board, and other products have already been made from wastes and from low-grade trees.

This country is the greatest user and producer of paper in the world. Every man, woman, and child in the United States uses an average of 192 pounds of paper in a year, more than twice as much as England, three and one fourth times that of Germany, and thirty-two times that of Russia. The Sunday edition of one New York newspaper requires the paper that comes from cutting eighty acres of forest. In 1937 nearly five million tons of wood for paper were produced.

For wood to be particularly useful, men must take it apart and reshape it. The Chinese, years before Christ, were making their paper from the papyrus plant, but it was not until the latter part of the nineteenth century that men learned the wasp's secret of making paper from wood. Eighty-five per cent of our paper is now made from wood.

Wood for paper must be finely ground or "pulped" into a soft mass. The pulp wood is first cut into two-foot lengths, "barked" in a great revolving drum, and held against grindstones with hydraulic presses until ground into very fine splinters that are carried away by a stream of water. A great sieve sorts out all knots and large splinters. The stream continues to carry the



A paper mill may be valued at more than three million dollars but it is worth far more than that to the community in which it is built.

finely ground wood into several great beaters where small amounts of rosin, alum, and clay are added.

The liquid then runs out on a wide belt of wire mesh. Here the water drains off, leaving a mat of fibers that is dried and pressed into smooth sheets between steel rollers. The paper is ready to be cut into desired widths and wound in great rolls of newsprint for the printing trades.

In making book and higher grades of paper, the logs are chipped into tiny bits which are then cooked and chemicals are added. The better grades have a percentage of rag which ranges from 25 per cent to 100 per cent.

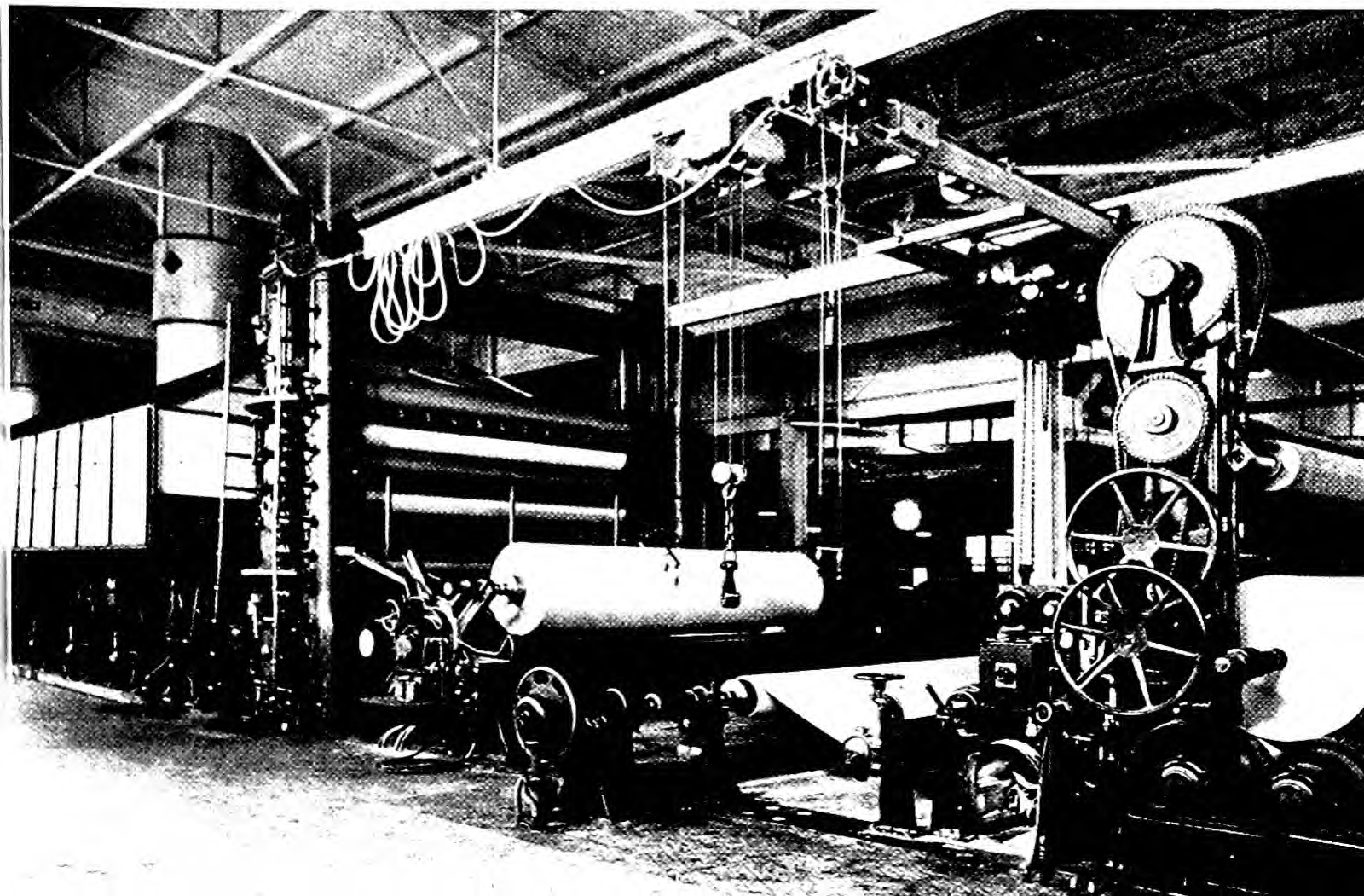
At first only spruce and hemlock were used for pulp, because they could be made into white paper without expensive bleach-

ing. After much experimenting a cheaper bleaching process was developed that allows southern yellow pine, poplar, balsam fir, jack pine, white fir, beech, birch, maple, gum, and larch to be converted into paper. Use of the quick-growing, less valuable trees is a real step in forest conservation. Plant breeders have even developed hybrid trees that grow to usable size in only half the time. They may come to have great importance. The more valuable trees can be saved for higher purposes. In recent years there has been a great movement of the paper industry to the South where cheap southern pine is available.

New uses for wood pulp are constantly being discovered. A Frenchman, watching a silkworm one day, learned the secret of how mulberry leaves are digested and changed into a jelly that is forced through small holes in the worm's body to form strong, shining threads of silk. Using wood instead of mulberry leaves, he created rayon, an inexpensive, though beautiful cloth that has tripled in use in ten years' time.

From the same wood jelly has been developed a transparent, strong wrapping material that is dustproof and waterproof.

America is the greatest user and producer of paper in the world. The Sunday edition of a large newspaper requires the paper from eighty acres of a good stand of forest.



Lignin, the element which makes wood useful for lumber, has long been a waste product in processes where cellulose is being used. Millions of tons have been poured away after the wood has been cooked for paper. There seemed to be no practical use for this element which makes up one third the weight of wood. For a long time chemists were unable to guess at its structure. It is durable and many things can be made from it such as wall board, tile, acid, road binder, and dyestuffs. As yet none of these can be made very practically, but may be in the future.

The chemistry of wood is in its infancy. Sometime in the future developments may come about which will make our present utilization seem very crude. A large part of forest products will then be used wisely.

The development of plywood has helped a great deal to make our diminishing supply of lumber last longer. Good logs are cut into large sheets of veneer. The wood is cut from the log by a large knife much as you would peel an apple. Sheets of this veneer are then glued on either side of boards of poorer quality. Thus a clear board four feet wide and eight feet long is produced. These plywood boards are strong and do not warp. A log which could be sawed only into a relatively few boards can be made into many square feet of usable plywood.

Great supporting timbers are also built from many thicknesses of plywood. These timbers, except for long stretches, are stronger and more durable than steel. When iron is exhausted it will still be possible to make beams from the wood we grow.

Refinements in manufacture help to conserve our forests, since, to be truly conserved, forests must be used. The preservation of wood where it is used has developed with our decreasing supply. Railroad companies now treat their ties with various creosote compounds to lengthen their period of usefulness. Telephone, telegraph and light poles, and, in some instances, fence posts, are so treated, often doubling their lifetime.

Our vanishing supply of timber has compelled the use of many substitutes for wood. To take the place of wood are asphalt shingles, steel and concrete fence posts and poles, steel window frames and steel furniture. If wood is as good as metal for a purpose, it is wise conservation to use wood, since trees can be grown again and metals can not. Forests must be used, and not hoarded.

Windbreaks and Shelter Belts

The Government, realizing the great value of trees as windbreaks, undertook, in 1934, to establish a series of shelterbelts across the Great Plains. Northernmost plantings were made in North Dakota near the Canadian border and extended south through South Dakota, and down a thousand miles across other

Shelter belts temper the winds that blow over the Great Plains and prevent drying winds from blowing seed and young plants right out of the ground. This planting of cottonwoods on a North Dakota farm is a mile long. The trees doubled in size the year before the picture was taken.

Great Plains states and into Texas. The plantings are made under agreements between the Government and the farmers. The farmers agree to cultivate them and keep out livestock, and the Government agrees to supply and plant the seedling trees.

The belts consist of ten rows of trees and shrubs. There are shrubs in the outside rows, then rows of taller growing trees with the tallest trees in the center of the planting. Only trees of adapted kinds, proved to be hardy to drouth, are planted.

The chief purpose of the plantings is to protect crops against dry, hot winds which formerly swept uninterrupted across the

plains, catching up topsoil from one state and carrying it often for hundreds of miles. To protect the soil from winds of every direction, the belts are zig-zagged across the plains instead of being planted in one straight belt. One farmer will have a mile of belt on his farm, then another a half mile or a mile away will have another belt.

Shelter belts are effective in decreasing wind velocity for a distance on the windward side equal to ten times the height of the trees and, on the lee side, twenty times the height of the planting. In addition, they prevent the quick drying of the soil during periods of drouth, and, in part, filter the wind of its cargo of dust. A low barrier of short, leafy shrubs—chokecherry, willow, sumac, lilac, buckthorn, caragana, and buffalo berry—catch the wind and force it upwards where it is pushed higher by taller trees—Russian-olive, plum, and Russian mulberry. American elm, green ash, Chinese elm, bur oak, and cottonwoods send the wind farther upwards. By the time it has dropped again to the earth, it encounters another strip of trees.

Besides furnishing protection from the wind the belts furnish ideal cover for wildlife, they give beauty to the plains, and in a few years they will be a source of fuel to the farmers on whose land they are planted.

Although it was feared at first that the young trees could not survive dry, hot years, that fear has passed. Survival of 60 per cent to 80 per cent of the seedlings has been common.

Naval Stores

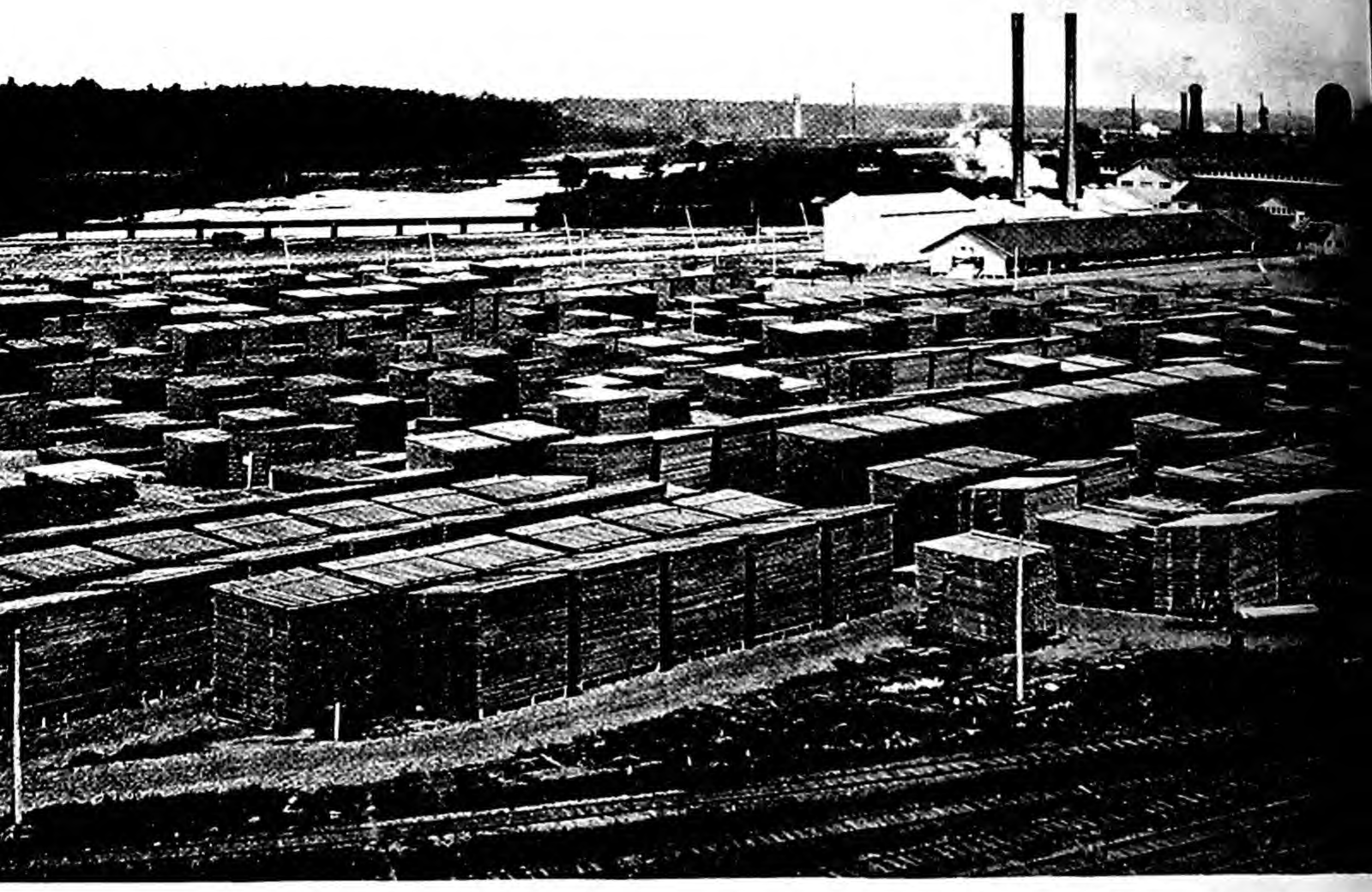
From the inside of living trees comes a valuable liquid that is called resin. When heated and distilled, it yields turpentine, pitch, and rosin. For thousands of years men have used turpentine and rosin to make their wooden ships watertight. Perhaps because they were so important in keeping the early navies afloat, the products were called "naval stores," and the thousand-mile stretch of longleaf and slash pine forests from North Carolina to Texas that supplied the resin became famous for its "naval stores" industry. From more than a thousand camps in the fragrant southern piney woods, the valuable gum is shipped to all parts of the world.

The turpentine is used principally as a solvent and a drier in paints and varnishes, and protects wood from decay and exposure just as it did in the live tree. Turpentine has an important place, too, in the manufacture of rubber. The bulk of rosin goes into

Every week during the growing season men cut large notches in the longleaf and slash pines of southern forests. A tree, to heal its injury, covers the wound with a soft gum which is collected and distilled into turpentine and rosin. A Florida worker is pouring gum from the collecting cup into his hand barrel.

soap, quick-drying paints and enamels, sizing for paper, grease, and printing ink.

Beginning in March, the longleaf and slash pines are "chipped" or cut open, and at once the liquid begins to drip. Men dip the gum from the box-like notch cut in the base of the tree,

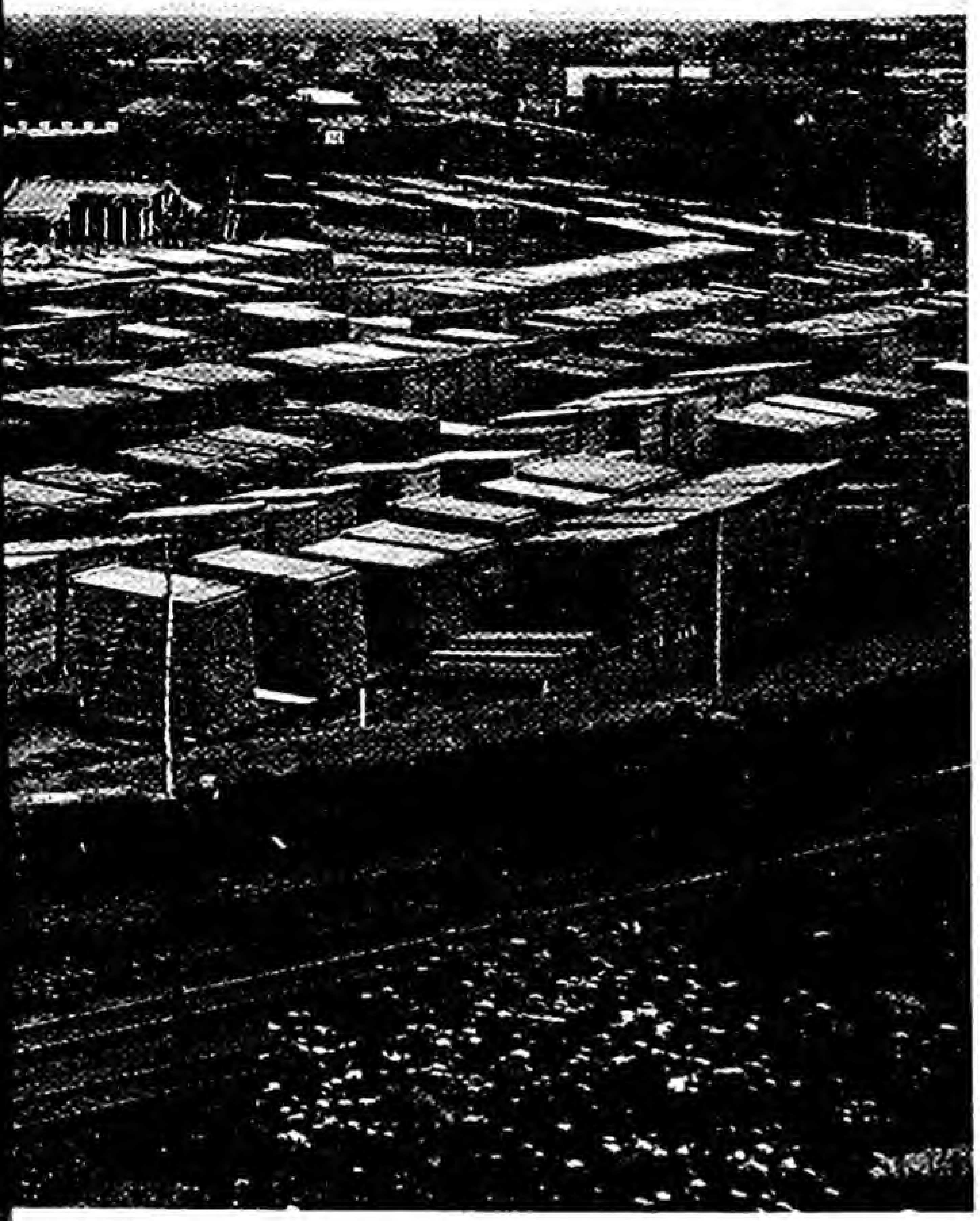


Cutting only as much timber from the surrounding forest as is grown each year will allow this gigantic mill to continue operating.

and scrape off whatever sticks to the cut or "streak." At a distillery in the woods the turpentine is separated from the rosin.

Real progress has been made in conserving the trees which are tapped for their naval stores. Grass and shrubs in the southern piney woods are burned almost every year. The boxes into which the crude gum dripped often caught fire and burned so deeply into the tree that it would be blown down by the first windstorm. Thousands of acres have been destroyed in this way. The chipping of a tree usually lasted for only three years, and by then the streaks had gone so far up the tree that much of the resin dried and the turpentine evaporated before it reached the box.

Instead of cutting a box, a cup is now hung below the first streak, into which tin gutters lead the gum. Since the cup is always moved up the tree to follow the cuts as they are made, very little of the low-grade "scrape" forms on the tree trunk.



There is no box at the base of the tree from which fire may start. The gum is of considerably better quality. Shallower cuts, it was found, encouraged a greater flow of resin. Trees could be chipped for ten or fifteen years and still be in good condition for lumber.

Forest Management

Forests, to be fully used and still provide a continuous living for the people who dwell nearby, must be kept on a sustained yield basis. The principle is the same whether it refers to the vast forests of the West or to the small woodlot on the farm. Forests are renewable, and may be grown and harvested somewhat like a crop of corn or oats.

There is this difference, however. A farmer can not harvest more corn or oats thar he produces in one year. But, for a limited time, he can harvest more wood than is produced each year. In time, therefore, he will have no wood left to harvest. The forest is not an annual crop that is planted, grown, and harvested in one season. The crop is dependent on the wood grown through a number of years.

To manage a forest on a sustained yield, one must know how much wood the area is producing every year. Studies of forest stands will show accurately how many board feet or cords a stand is growing. This growth is, then, the amount that can be cut each year on a sustained yield basis. More often, however, cuttings are not scattered over the whole area, since trees must be mature for harvest. A simple illustration is to assume that a plantation covering 10 acres be planted each year in a county for a hundred years before any timber is removed. There would

then be one thousand acres of forest in the county, so arranged that ten acres of one-hundred-year-old timber could be cut every year forever. Continuous planting of this kind would represent a large-scale sustained yield plot.

A central Arkansas farmer sells for about $130 yearly the wood resulting from thinning his ten-acre farm woodlot. A sustained yield is possible even on small areas.

But just as important is the small farm woodlot. Where trees grow naturally, it is an essential part of any farm, furnishing fuel for cooking and heating. Properly located, it can protect from the harsh winds and snows of winter, and make life more pleasant during the heat of summer. Home-grown hardwoods and pine cut the lumber bill. In many cases, the woodlot supplies a much needed cash crop. A few acres of trees grown carefully in the forest community can be immensely valuable. Work in the woodlot can be done at times when other work may be slack. No special machinery is needed. Forest land may be made to produce a harvest annually, or every five or ten years, depending on the species of trees and how they are managed. The chief idea is to keep the land producing continually, reproducing the forest

as soon as it is cut, thinning it so that it will make the best possible growth, and protecting it from fire and insect pests.

Reproducing a stand of timber may be done either by artificial or natural means. In the first, seedling trees are grown in a nursery and transplanted to the forests. Under natural means, the crop of mature timber is so cut that a new crop begins to grow directly from the seed of the standing trees. Scattered mature trees are left standing to insure seeding the cut-over land. Natural reproduction is cheaper and far more widely used than artificial replanting.

Reforestation is the word that describes the job that must be done to replenish a forest that will not or is not reproducing itself. The Government is doing most reforesting, since the work is costly for private owners. Large nurseries have been established near national forests in most forested sections. They supply seedling stock to be planted each fall and spring on public lands. The work, besides being costly, is slow, since it takes more than a thousand trees to plant an acre. Millions of nonproductive forest acres will require a great supply of trees. Even if all the money necessary were available, it would require from one hundred to two hundred years to restore the least productive parts of our once magnificent forests. The work can be speeded, however, if every boy and girl takes an active part.

Let us trace the history of a woodlot from the time it is planted. About a thousand little trees are planted to an acre in the spring. Not more than two or three hundred can possibly mature, but the soil is carefully protected by the thick growth. The trees must begin crowding each other at an early age to shade off the side limbs and force them to grow long, clear stems. In 15 to 20 years, thinning is necessary to make more room for roots and tops to keep trees growing as fast as possible. Perhaps 20 per cent will be cut and used for fuel or lumber. Such a cutting may be repeated every 20 years until the crop is 80 years old. By then the remaining trees will either be mature or of profitable size, and it will be time to consider starting the next crop, but the shade will be still too dense to allow seedlings to start growing.

When the stand is about 90 years old, 20 per cent of it may be cut to allow decomposition of the litter and preparation of

Strong, mature trees which can stand alone against the wind must be left to seed the soil for a second crop. Notice the cones dropped by this ponderosa pine in Oregon.

the seed bed. After a good crop of seed has been produced, another 35 per cent of the stand may be cut. There ought then to be enough light for the seed to germinate and grow. After the seedlings are well established, the remainder of the old timber is cut and the new crop is ready for rapid growth. This is one form of the sustained yield program.

The supply of virgin timber will last only 30 to 40 years more at the present rate at which it is being cut. This fact in itself would not be alarming if young trees were growing up to take its place. Less than five per cent of private forest lands is, however, being managed on a sustained yield basis.

What has unwise management meant already to the lumber industry? All through the Lake states and the South are towns which grew up around a busy sawmill when virgin timber was plentiful. These towns and cities built schools, banks, stores, and city halls. But the life of the town was only as long as the timber lasted. When that was gone, it no longer had any means of support. The town died. Now there are only empty, decaying buildings, and grass is growing on the streets that once were busy.

What must unwise use of forests mean to existing lumber towns? If the industry is deforesting large tracts without regard to reforestation and sustained yield, if fire is following logging operations and killing young trees, or if cutting is causing the industry to reach out farther than it can profitably transport timber, then the town which supplies the industry must certainly die. Men will be thrown out of work. Schools will be closed, and people will move away, trying to find homes somewhere else. Had the neighborhood only planned for its future, it might have lived from its surrounding forests for all time, keeping its men at work and prospering.

The Government has been active in planning how to protect forests for use, and in applying the ideas of a sustained yield. Most of the timber lands set aside from the public domain as national forests will remain productive indefinitely under their present management. This is encouraging, because public ownership must be a part of the answer to the forest problem.

The history of waste in our forests has pointed out that too many individuals think only of their own profits year by year to be concerned over a supply for the future. It has demonstrated

that, if education will not help them, then control and regulation by the Government must. Laws might need to be passed that would specify how much timber can be cut from a tract of woodland, and what replanting must be done each year.

The other possibility might be to include more of the privately owned forests in public ownership. In parts of Europe the "town forest" has been in existence for years. It offers a beautiful recreational spot near at hand, fuel, and building materials for the inhabitants, in return for replanting, thinning, and protecting it from fire. Citizens in several hundred German towns get dividends from their community forests. Two thirds of Switzerland's forests are owned by communities. Such forests are as valuable after long use as they have ever been. What a contrast to America's ghost towns!

Just how much forest land ought to be in public ownership is not known. In our democratic form of government there will always be a place for privately owned forests. But, when probably not more than five per cent of privately owned forests are being wisely handled, some supervision seems necessary. The area in public forests ought to be large enough to guarantee that the needs of industries directly dependent can be supplied. Wisconsin has established county forests in 25 counties on an area now totaling 1,650,000 acres. Several eastern towns have established community forests.

Forest conservation requires action, and that action must be immediate. Forests are the slowest growing of the renewable resources. If there is to be progress, it must begin while some part of the forest resource still remains. If we are to see improvement in our lifetime, we must begin work at once.

The nation must have forests for fuel, for lumber, and for the great number of other practical uses to which wood has been put. But forests are closely related to other resources, and there are other needs for conserving them. On steep slopes protective forests must help to prevent erosion. Forests must regulate the flow of streams, furnish a steady source of power, and lessen the danger of floods. Forests must halt the sweep of drying, dust-laden winds. Forests must give wildlife food and homes. Forests must give men the soul-filling pleasure of a stroll among tall, friendly trees.

The Christmas tree industry has grown to be a five million dollar business. Trees are inspected before they leave the woods. Heavy fines are being imposed on persons who cut without regard to ownership.

To accomplish these ends, let us recount our aims. We must put to work all idle, cut-over lands. We must manage all forests on a sustained yield basis so that the timber supply will be constant and unending. Mountain forests must be kept unharmed. The varied character of forests must be preserved to furnish proper conditions for wildlife. Fires must be prevented before they are started; but, once begun, a corps of trained men must be ready to fight them. Overgrazing must be prevented when it hinders the growth of young trees. Careful logging must not allow immature trees to be injured. On that part of the forest area which had been so badly handled that it would not other-

wise become productive for generations, reforestation must be carried on to speed up the growth. An increasing portion of our forests must be either regulated or owned by the Government.

If the youth of America learns this lesson well, our nation will be one with forests self-sustaining, valuable, and beautiful.

REVIEW QUESTIONS

1. What are the greatest uses of the forest?
2. How did the forest aid in settling and developing America?
3. How has cheap lumber made American life more pleasant?
4. List the products that are taken from the forest and tell whether or not they have been manufactured.
5. How does the forest indirectly benefit and protect the soil, streams, wildlife, and man?
6. How are trees, shrubs, birds, and animals dependent on one another?
7. Why are trees which grow in thick forests especially valuable?
8. Describe a tree's growth, showing importance of cambium and bud.
9. What are the causes of forest fires? Name the three kinds and give examples to show their destructiveness.
10. How do forest rangers locate and fight fires?
11. Why are imported tree diseases usually more destructive than native ones?
12. How far has waste gone in destroying our original forests?
13. In what two ways has the Government aided in conserving forests? How does each benefit the human resource?
14. What improvement might be made in the practices which are still wasting our forests in the woods and at the mills?
15. Describe the process of paper-making. What savings can be made?
16. To what new uses has wood pulp been put? Are these higher uses?
17. Of what value are shelter belts?
18. Describe the "naval stores" industry. What forest-conserving practices have lately been developed?
19. How has a wider use been made of lumber?
20. Why is a sustained yield of utmost importance to forest villages?
21. Why should every farm include a woodlot?
22. By what two means are forests reproduced?
23. How can town, community, county, state, and national forests provide a source of income, employment, and recreation?

SUGGESTED ACTIVITIES

1. Many conservationists are coming to believe that the forest's greatest value is its vital influence on soil-building and water regulation. Make a careful study of this most important value of the forest.

2. What near-by industries are dependent upon trees? How many men are employed? For what uses are forests important in your community?
3. Make a chart of the trees and principal shrubs found in your locality. Indicate what uses are important for each. Gather samples of hardwood and softwood lumber. Learn to identify the kinds.
4. Visit with an old settler. Find out what changes have occurred in population and industry.
5. Plan a trip to a factory which uses some forest products. Is there necessity for a constant supply of raw materials? Why?
6. Make a careful study of the wild flowers which grow in and near your forests. Which ones need protection?
7. In a woodlot, in a park, or in a museum, find the cross section of a tree. Count the annual tree rings. What history do the rings reveal? Are there evidences of cycles of rainfall?
8. Plan the arguments you would use in convincing a landowner of the value of a woodlot.
9. Carl Schurz, John Muir, Bernard E. Fernow, Franklin Hough, Theodore Roosevelt, and Gifford Pinchot are names that will not be forgotten. What problems did each one face?
10. Collect samples of the seeds of trees which grow locally. After you have learned to identify them, plant them either indoors or out. From your experience how would you recommend they be planted for reforesting an area?
11. After class discussion meet with city or county authorities to decide where your most desirable seedlings ought to be planted.
12. After consulting with the landowner, make the proper planting of shrubs or trees to control the erosion or rapid run-off of water which you may have found to exist. Your class could leave no better proof of its energy than a city or county park. No matter how small, it would benefit the human resources.
13. If you have a stand of trees near-by, study them closely to discover whether they are sustaining themselves. How old is the stand? Could it be made to grow more timber? Are diseases, insects, or overgrazing injuring the trees? Explain to the owner how he may improve his practices. Are there wastes in cutting?
14. Ask your state forester to discuss the forest laws. Which regulations need enforcement?
15. Arousing public opinion has always been the first step necessary in conservation. Design a poster that will aid the class in a definite campaign.
16. Find how much forest land remains in your state. Locate the state forests on an outline map.

Debate: Resolved, That the axe is the true preserver of the forest.

Grass is the sign of a healthy nation.

CHAPTER SIX

Grass As a Resource

A BAND OF explorers in 1870 marched across the great western prairies. Along with them went fifteen hundred Indians, a thousand horses, five thousand sheep, and five hundred cows. Wherever the party walked, their trail was lost in the deep native grasses. After the huge procession of men and animals traveled by, the tall grass sprang back and waved in an unbroken sea that left no tale of their presence.

This sight was new to the explorers, and one of them was so impressed with the character of the vast, level grasslands that he wrote in his diary: "I believe that all the flocks and herds in the world could find ample pasturage on these unoccupied plains and the mountain slopes beyond; and the time is not far distant when the largest flocks and herds in the world will be found here, where the grass grows and ripens untouched from year to year." That man was a prophet and his prophecy for a time came true.

Had they gone farther, the explorers could have seen a rich land of waving grass from the broad Mississippi prairies across fertile valleys and plains up to the very Rockies. The great grasslands at one time extended from the forests of the Mississippi Valley to the forests of the Pacific Coast, and from Canada to Mexico.

Grass deserves a place at the side of soil, water, forests, wildlife, and minerals in the hall of useful resources. Indeed, its leaves and roots are woven throughout the earth's pattern of natural wealth. John J. Ingalls has written:

> Grass is the forgiveness of nature—her constant benediction. Fields trampled with battle . . . grow green again with grass. . . . Streets abandoned by traffic become grass-grown, like rural lanes, and are obliterated. Forests decay, harvests perish, flowers vanish, but grass is immortal. . . . Sown by winds, by wandering birds, propagated by the subtle horticulture of the elements

Grass binds the soil and protects it from wind and rain.

> which are its ministers and servants, it softens the rude outlines of the world. It invades the solitude of deserts, climbs the inaccessible slopes and pinnacles of mountains, and modifies the history, character, and destiny of nations. . . . Banished from the thoroughfares and fields, it bides its time to return, and . . . silently resumes the throne from which it has been expelled but which it never abdicates. It bears no blazonry of bloom to charm the senses with fragrance or splendor, but its homely hue is more enchanting than the lily or the rose. It yields no fruit in earth or air, yet should its harvest fail for a single year famine would depopulate the world.

Soil is firmly bound together and anchored by the mass of fibrous rootlets beneath grass. The leaves of grass soften the fall of raindrops and keep them from eroding. Running water is tripped into walking by grass, and made to work much longer before reaching the ocean.

The forests find that grass steadies their hold upon the earth, and keeps the soil porous and fertile. Much wildlife feeds upon grass and makes its home in its protective cover. Thus grass is a necessity for keeping the earth in good health.

In its cultivated form, grass furnishes a great share of the food supply for the human resource. Wheat, rye, oats, barley, millet, corn, and sugar cane are all members of the grass family. Even bamboo belongs among the grasses. The history of the cul-

tivation of many grass crops is shrouded in antiquity. Since the care of cultivated crops is really a study of agriculture, they will not be considered here. The grass resource will be taken to mean those natural, native grasses found growing here when the West was opened.

The Grasslands

The great grasslands of America are commonly spoken of as the range, or as range land. Actually, however, range land includes all land where grasses grow extensively and which may be used for grazing livestock. Even forests, where they are not too dense, contain much valuable forage, and supply summer range for millions of head of livestock. They are, therefore, included as range land. Through this chapter, range land will include all areas where the resource of grass is important.

About 46 per cent of all the United States is range land, an area of 884 million acres. Most of this is west of the one hundredth meridian. One third is now owned by the State and National Governments, and two thirds by individuals, railroads, and land and cattle companies. That part of the range which is public domain includes national forests, national parks, and Indian reservations.

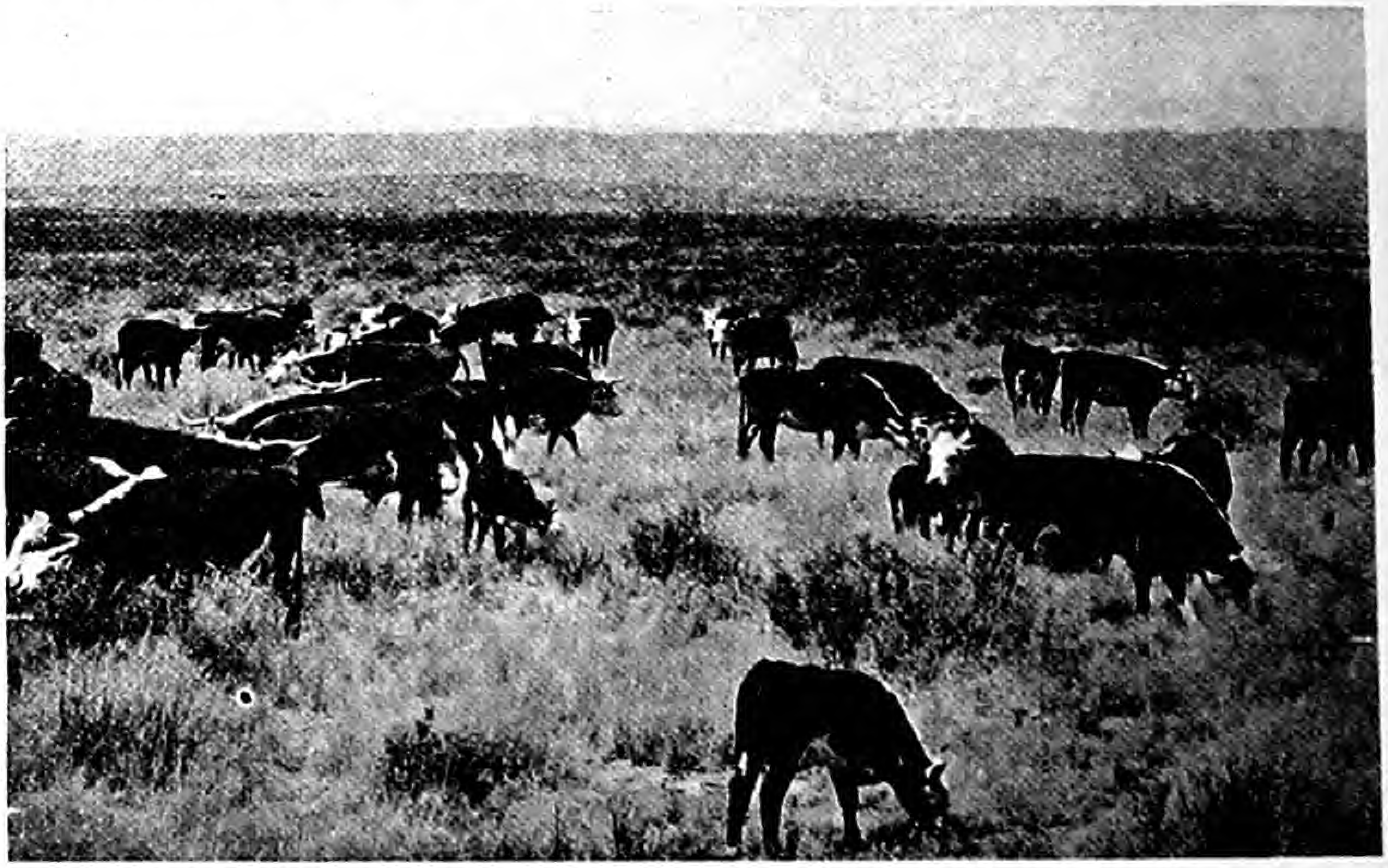
After years of abuse, these western range lands still support some 25 million head of cattle, and 40 million sheep. More than 70 per cent of all the wool grown in the United States comes from the range in addition to 30 per cent of the nation's cattle and calves and 55 per cent of the sheep and lambs.

Let us look at the character of this broad grassland area.

Its borders, first of all, have been roughly set by the average rainfall in any area. Some believe that repeated prairie fires prevented forests from taking over the area of grasslands. This has had an influence upon the borders, but perhaps no more than that. In the temperate zone at least twenty inches of rainfall a year are necessary to support a natural forest. Trees will grow in drier places if they are planted, but they will not reproduce and maintain themselves there naturally. On the Atlantic Coast, with an annual rainfall of from 40 to 55 inches, there is unbroken forest. To the west, the rainfall decreases steadily to the hundredth meridian, where it falls below the necessary twenty inches.

There the forests vanish entirely and the grasslands appear. Until you reach the Cascades and Sierras, there is moisture enough only to support a growth of grass.

Besides setting the borders of the grasslands, the rainfall determines the kind of vegetation that will grow. The rain that



The western range with its broad prairies and plains provides the nation's greatest pasture for cattle and sheep. The entire range, including forest land and open land wherever grasses are important, comprises almost half the land area of the United States.

does fall very often comes in great torrents that often badly erode land. Rainfall is poorly distributed over the growing season, and so there are great periods of drouth that test the hardiness of each grass type. Only the strongest survive.

The drouth-resisting native grasses sometimes grew as high as a cow's back. Very little of such grass still remains. Other grasses were somewhat shorter, like the western wheat grass, but covered the ground very quickly with a dense sod. Still shorter were the buffalo grass and grama grasses that could withstand the severest drouths and yet produce forage.

All the grasses protected the ground from the fierce, beating rains, and their matted roots held the soil in place. Most of them

had the peculiar faculty of curing themselves where they stood without being cut for hay, thus making year-round pasturage possible.

The original grasslands were not all alike. Neither are they today. For the first few hundred miles they are known as prairies, long stretches of treeless land, either level or slightly rolling. Here the grass used to form a dense, unbroken sod, so tough that the early settlers, when they could not get lumber, cut it in long strips and made their houses of it. Buffalo moving in mile-long processions were alone able to cut through trails. The principal grasses were big bluestem, little bluestem, Canada wild rye, sand dropseed, and switch grass. The rainfall and growth habits of these grasses made possible the formation of a dense, unbroken sod. The thick sod and long grass had protected the area from erosion by wind and water. It did not take the pioneers long to discover the fertility of the soil, and the true prairie rapidly disappeared. Little attempt was made to conserve the native grasses although they probably would have proven more productive than most of the introduced crop plants. This area, where vast quantities of cultivated grass crops are produced each year, rather quickly came to be called the "bread basket of the nation." It can no longer be called grassland.

Gradually, the rainfall dwindles as one moves westward. From the western edge of the sod-grass land to the crest of the Cascades and the Sierras it is too light to support many of the prairie grasses. Instead, the grass becomes shorter, and often grows in bunches. This is the bunch-grass country, where grass grows in clumps with bare spaces between. These bunches do not protect the soil from the beating rains as well as the prairie sods, but they have masses of fibrous roots in the upper foot of soil that hold the soil in place and prevent erosion.

Throughout this section, particularly to the east, there may be short grasses and mixed prairie grasses. Toward the west the grass is more commonly of bunch-grass nature. In this region, the principal grasses were grama grass and buffalo grass, with considerable needle-and-thread grass, needle grass, sand dropseed, and switch grass. In the mixed prairie and plain district, grasses such as the western wheat grass and the western needle

Although only narrow-leaf bunch grass covers much of the range in the Southwest, it will fatten great numbers of cattle if properly managed. This is an Arizona range.

grass became more prominent. In Texas curly mesquite furnished much forage. These lands with their self-curing grass crop furnished ideal grazing, and from Texas to the Dakotas huge herds of livestock grazed and fattened. To settlers who were used to the prairies of Iowa, Illinois, and Minnesota, the short-grass and bunch-grass country gave promise of being as excellently suited for farm land. There were no rainfall records to warn persons of the less favorable growing conditions.

Farther west, in the same section, as the rainfall becomes still more scanty, the short-grass and bunch-grass country gives way to the desert plains. There are scattered bunches of grama grass, three-awn grass and vine mesquite. Perennial shrubs and annual weeds help to make this range country able to support large numbers of livestock, while the sparse growth on the western plains seems hardly capable of feeding a single cow.

Conditions on the western range are peculiar. In the early summer forage is abundant, but later in the summer the grass dries over large areas. Two tracts are, therefore, ordinarily required—one for winter and one for summer range. Vegetation

is green on the mountain slopes where there is moisture all summer. Cattle and sheep are driven there to graze. But the snow is deep in winter and stock can not find a living. In winter the dried grass is available on the plains, since the snow does not get very deep. The stockman who had access to the mountains in summer and the plains in winter could support his stock the year around. Most of them who were near the mountains had their ranches on the plain and drove their stock to the mountains for the summer. There are now at least 10,000,000 head of stock—sheep, cattle, and horses—that are supported in that way.

Unfortunately, there was a great deal more winter range than summer range. Stockmen raised more cattle and sheep on the plains in the winter than they could feed on their summer range. This condition led to strong and often bitter competition for summer range, since it was practically all public land.

How the grasslands were opened to grazing and farming is an interesting part of American history. It is a story of conflict and war. The conquest of the range has been rapid and spectacular. Here only a century ago roamed Indians and buffalo where now are cities and farms, railroads, and paved highways. There were no forests to be cut and stumps to be removed. All that was needed was to turn the sod and plant the land.

Until 1804 when Lewis and Clark crossed this vast grassland empire, little was known of the region. A few stories were told by hunters and trappers, but were generally regarded as unreliable. These men were, no doubt, the first to announce to the Indians occupying the territory they traversed, that the extensive area had been purchased by the United States. These men made explorations as far as the Pacific Northwest.

Pioneers poured over the Cumberland Gap and herded their cattle before them. The buffalo were driven farther west and their water holes taken over by the settlers. Even before the westward flow of immigration over the mountains began, great herds of cattle were being driven eastward from the west coast, and from Texas and New Mexico. Eventually the two streams met and the prairies and plains became dotted with broad herds of grazing cattle. Instead of buffalo now there were gaunt Spanish cattle with long horns.

Grass and the Livestock Industry

It was not until after the Civil War that the cattle industry developed. Cattle that had been bottled up in Texas during the fighting were taken north to pasture. The country was growing by leaps and bounds. Its industries were broadening and its population expanding. There was a market for all the food that could be produced. But the big difficulty was to transport food and raw materials.

The cattlemen of Texas solved the problem and with it the problem of season-round range for their stock. Fat steers could transport themselves to market, and thus grazing fitted easily into pioneering days that knew few railroads or highways. Grass matured earlier in the South than in the North. So, as the grass in Texas passed its prime, cowboys herded their cattle northward. They gauged their speed so that everywhere they caught the grass in its prime. Battles with Indians, struggles with blizzards, and the hardships of drouth were their lot. Often they found the watering places fenced and taken up by settlers. Wars between settlers and cattlemen developed. Rustlers, outlaws of the West, stole cattle along the way. By fall the cattle were in good condition and fit to be marketed easily in Kansas City or Chicago. It was profitable business, but depended almost entirely on having a supply of water along the route. Often the fences that settlers put up to protect their water holes were destroyed and the settlers killed.

In the 1880's, Scotch and English capitalists poured money into the cattle business in the West. The investors were interested principally in getting quick returns from their money.

The conflict between settlers and cattlemen dwindled to almost nothing when sheep came in the 1890's. Cattlemen looked with scorn on sheep and sheepmen. Sheep will eat much vegetation that cattle refuse to touch. When they have passed over a piece of range land there is little left for cattle. Sheep kept coming from Mexico in increasing numbers, and races ensued to see who could get the grass first. Sheep were crowded on the range before the vegetation was well up. As much of it was trampled out as was eaten. The race occurred in the middle of the lambing season, and, as a result, many lambs were lost.

The effect on the range was even worse. Grass and shrubs were destroyed so completely that the ground was left bare. Each year it was able to support fewer and fewer stock. The industry suffered. Since the land belonged to no one, no one took care of it. The hard-tramped ground soon began to erode and gully.

First came the cattle, then the sheep, and then the plow. Cow paths on the hillside testify that once there was good grazing here, but overstocking the range killed the grass and left the ground barren.

To the overexpansion of the livestock industry, the wars between cattlemen and sheepmen, overgrazing, erosion, and a gradual decline in the worth of the range was added one more blow at the grass resources. The final abuse of our western ranges came during the first World War. The cry, "Food will win the war," was heard throughout the land. With the great demand for food, ranges were stocked far beyond their normal carrying capacity. Large areas of grassland were turned "wrong-side-up" and planted to wheat. A succession of wet years and the fertility stored by countless grass crops made the venture seem reasonable and profitable at first. Huge mechanized farms developed rapidly in the semi-arid regions of the plains. Men were sure they would soon be rich.

Then a change in rainfall came, crops failed, and the bankrupt people moved away. But the abandoned land could not

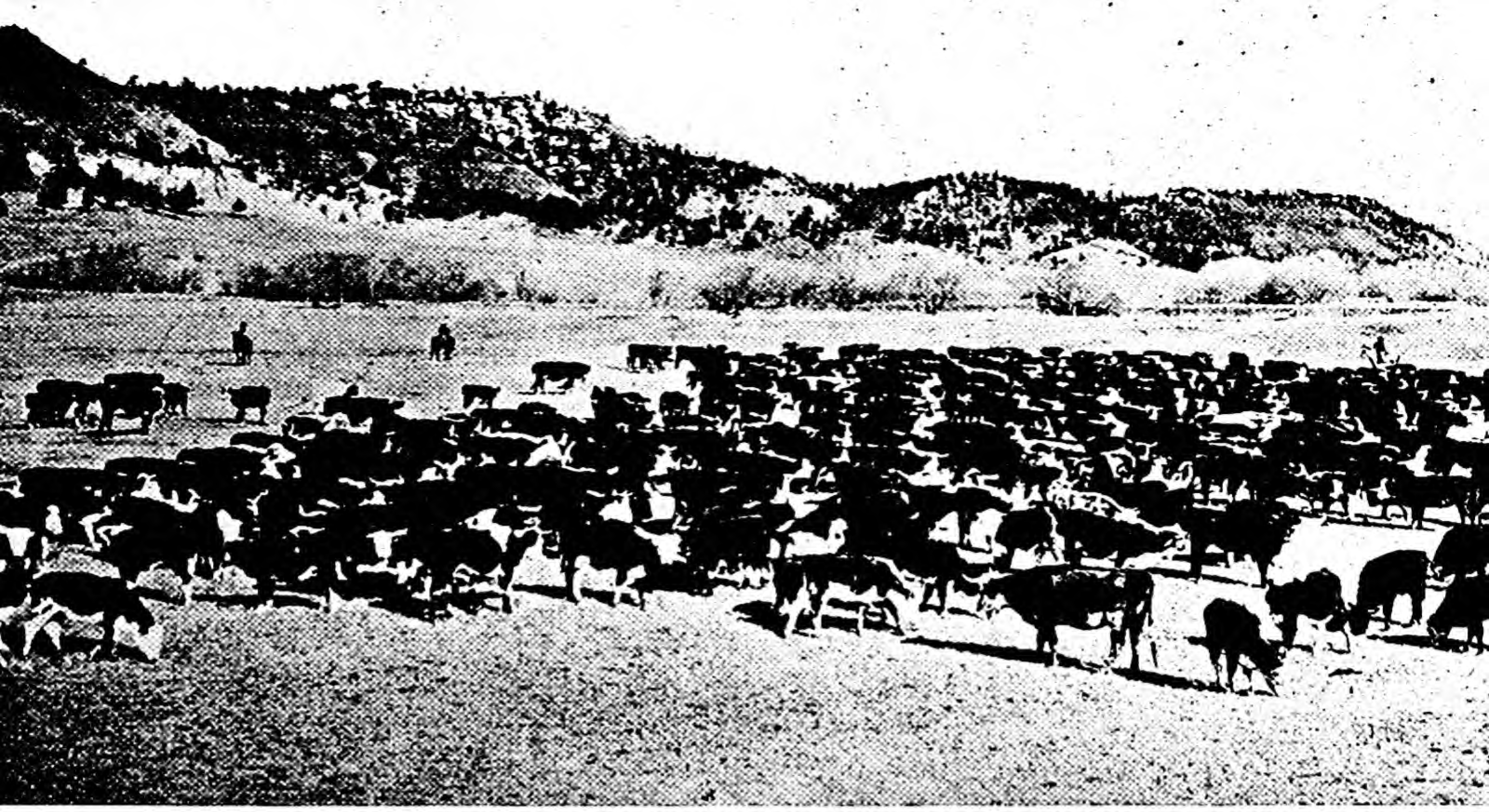
return to the many-rooted grasses that had once bound the soil in place. Instead it grew up to scanty-rooted annual weeds that let the wind take ownership of the soil. The dust bowl was the result, as we have already seen.

Much of the western range from early times has been a part of the public domain. It has been in no sense a reserve for keeping its resource intact but was held by the Government in hopes that somehow it would pass into private ownership, be developed, and become productive. The Government was little concerned about these areas. It took no better care of its property than the private owners took. No one had the legal right to an acre of public domain. Thus there was no incentive for leaving a single blade of grass behind. From earliest times the public domain furnished free grazing until around 1880, when large cattle farms fenced off great sections of it for their own use. Some companies fenced off as much as a million acres. When a special law made fencing the public domain illegal, grazing was again made free.

Grass was free to the first comer. Cattle were driven on areas much too early in the spring. Shepherds followed the melting snow up to mountain meadows. When grasslands are grazed too soon, the good forage plants can not gather strength for the summer. They soon disappear, leaving a growth of weeds. The range was stocked too heavily with cattle and sheep.

The important point is that the range was very nearly ruined. It is now badly gullied and, in many places, completely bare. In its present condition its productivity is very small. The destruction of the grazing on these millions of acres has naturally increased the overcrowding on the grazing lands that remain. About 160 million acres of range land in the West have lost 40 to 50 per cent of their productivity. Bank failures, closed rural schools, and ghost towns have resulted in many parts of the range.

The presence of settlers and large land and livestock companies, all trying to push the range to its limit, quickly resulted in overstocking. In the 20 years from 1870 to 1890, the number of livestock in eleven western states increased seven times. Even at the present, the range is carrying 70 per cent more livestock than it should.



Starvation of cattle came as a climax to overstocking and drouth. Starving cattle are a terrible sight.

Overstocking of the range went on while stockmen were not aware of it. The prairies had piled up a large reserve of cured grass from year to year. More stock than the range should have carried were gradually removing the supply. To conceal the fact still more, a few wet years encouraged much greater grass growth than normal. Somewhat later, grass began to draw upon its store of natural water in the soil. Finally, the two factors —overstocking and drouth—combined to produce the disasters of 1886 and 1893 when thousands of cattle starved to death.

In addition to overstocking, early grazing, and general lack of control of the range, there are still other forces at work to harm the grass resources. Large land monopolies were formed which claimed and fought for the idea that they could own all the land they could fence. Particularly in the South, land was burned to encourage new growth of grass. Burning had the effect of killing bushy growth, stimulating erosion, and allowing valuable plant food to go up in smoke.

Effects of Misuse

What is the condition of the range today?

Lack of governmental regulation of its public domain, too early grazing, overstocking, and the carelessness of large cattle

companies have taken a heavy toll of our grasslands. Averages over the entire range show that our grass resources are more than half destroyed. About three fourths of the range has declined during the last 30 years, and only one sixth improved. Not much more than five per cent of the range is in an entirely satisfactory condition. Government reports show that it will take 50 years to restore the range sufficiently to carry the 17 million head of livestock now found grazing on it. Another 50 years will be needed to restore the rich cover of sod it once had, and bring it to its former capacity of 22 million head.

Over much of the range the soil has been exposed to erosion. Local floods have increased in number and destructiveness. Irrigation reservoirs and streams have rapidly silted up and threaten the life of irrigated farms. This penalty is a big price to pay for the mistakes of a few hectic years of development.

The problem of restoring the western prairies and plains to grass is a serious one. It is serious because it can not be done in a hurry, and any remedy must be started at once.

It is serious, too, because it involves an area of almost half the entire land surface in America.

What are the practices that go to make up the best use of our range?

"Fewer livestock—more grass" might well be one slogan to follow. Too much grassland turned wrong-side-up and overgrazing have long been the curse of the plains country. Careful control over the number of head to be allowed on a plot of grass is the first important consideration. It has been possible to show that restricted grazing actually pays in dollars and cents. A four-year experiment completed near Miles City, Montana, points out the losses by overgrazing. A heavily-grazed tract carried a cow for every 23.1 acres; a lightly-grazed tract, a cow for every 38.8 acres. At weaning time, the average weights of calves from the heavily-grazed plot was 249 pounds, and from the lightly-grazed plot, 297 pounds. Considering both range and hay costs it required $4.31 to produce each hundred pounds of beef on the lightly-grazed area, and $6.21 on the heavily-grazed.

An overgrazed range, besides cutting profits, also increases the losses of livestock. Deaths are almost twice as many as on a range properly grazed. Why do the greater death losses occur?

About 180 million acres of range land in the West have lost up to half of their productivity. Banks have failed, schools have closed, and towns have disappeared because the grass has been killed. Gullying is completing the ruin of this stretch of range.

The first thought is that there is not enough forage. But overgrazing, in addition, changes the character of the plants that grow on the grassland. The nutritious plants disappear and are replaced by weeds and poisonous plants. Many who have not heard of the loco weed do not realize that to the livestock of the western plains it is a very real menace. The loco weed, death camas, larkspur, and lupine are responsible for the death of five per cent or more of the stock on some ranges. The size of the calf and lamb crop is sometimes reduced. Many other animals are brought to market underweight and sold at a lowered price.

The effects of overgrazing on the range itself over several years are even more important than its effect on stock. Cattle. sheep, and horses become so hungry that they eat down to the

Complete destruction of the range in some areas means overgrazing in others. The grassland at the left is a picture of range wealth resulting from controlled grazing. At the right is the poverty which can result from misuse of a natural resource.

roots of the plants and often in their crowding and pushing trample out more forage than they eat. The hard-baked ground is trampled to dust and is blown away. There is nothing to hold the soil in place against torrential rains, and great arroyos, or "washouts," are formed that can not be reclothed with vegetation for years and years, and then only at great cost.

Still another evil results from overgrazing. The grasses most desirable for forage are killed. In their place come weeds with a single long taproot which is completely unable to bind and protect the soil. The roots of most desirable range grasses are found in the greatest abundance in the first 15 inches of soil. They offer a resistant and binding understructure against eroding water. This mantle of roots with the accompanying turf enables the soil to absorb and retain moisture. Blades of grass shield the soil against the impact of downpouring rain, while weeds allow

the soil to be muddied and eroded. In addition, cattle and sheep do not readily eat the thistles, pepper grass, and pigweeds that replace good grass.

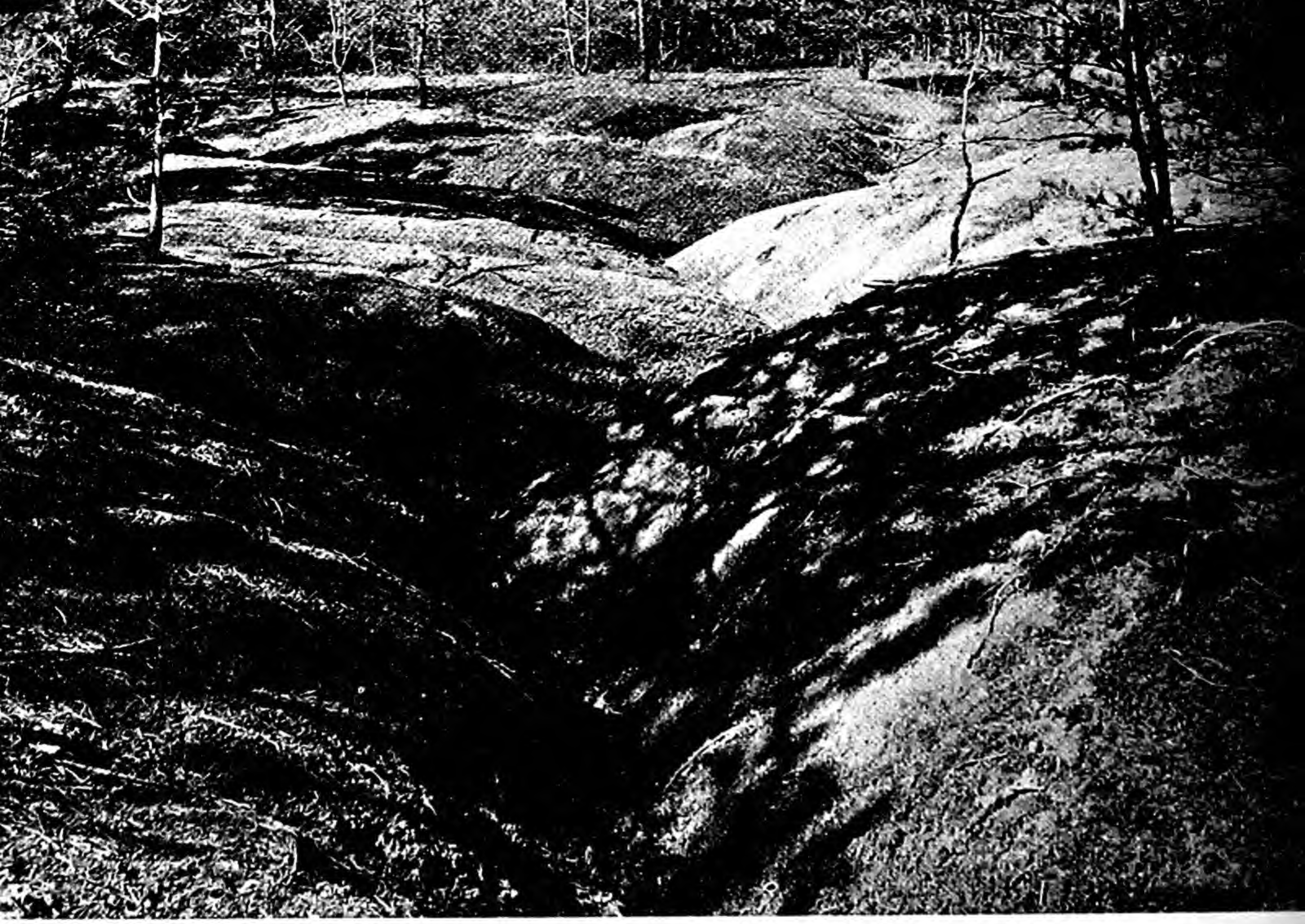
Management Is Needed

If grasslands are to have proper care, they must be reseeded to grass wherever the sod has disappeared. The species of grass to plant deserves study. In general there are two types of valuable grasses that may be seeded. One type grows tall with wide leaves and produces a large quantity of forage, but is less able to withstand continuous or year-long grazing, because the leaves are produced rather high up on the stem. It does not allow enough food to be stored in the root, and ordinarily does not reproduce easily or sufficiently by root stocks.

The short-grass type withstands grazing much better. Short grasses produce much leafage close to the soil surface, and are not readily eaten. Blue grama is perhaps the most typical of this kind. It is highly nutritious and much liked by cattle. It is drouth-resistant and is able to remain dormant during drouth periods. As soon as rains fall, it greens up and begins growth. Blue grama roots appear in the upper 18 inches of soil. This grass and others like it are well adapted to situations where, because of light rains or a compact soil, water passes through slowly, and much of the moisture is confined to the top six or eight inches of surface soil. The grama, buffalo, and wheat grasses, like all the dry-land grasses, have narrow leaves, whereas the grasses in areas of more abundant rainfall have broad leaves. Broad-leaf grasses with more leaf area exposed to the sun and wind give off more water vapor and, therefore, need much moisture. The narrow-leaf grasses respire little and are hardy to drouth and heat.

Other grasses may be better suited to your locality. It will be interesting to discover which species can do the best job of soil-binding, which can withstand the heaviest grazing, and which is most sought after by cattle and sheep.

With this information, run-down ranges and pastures can be reseeded to preserve the soil and improve the quality and amount of grass. After reseeding, grasslands will establish themselves in from two to five years if they are properly cared for.



Misused slopes, such as this one in North Carolina, need not remain barren and subject to further erosion. See opposite page.

In dry localities, the time will necessarily be longer. In Russia, grass seed is sown by airplane.

Wise management of the range means that changes will be made to keep in harmony with wet and dry years. During periods of drouth, cattle and sheep ought to be culled out closely, allowing the best animals to remain for producing the next year's crop. If it is not advisable to sell stock, they might be fed hay that was stored for just such an emergency. Ranchers now generally allow some forage on the ground as insurance against poor growing conditions the following year. Correct seasonal use of the range is also important. When seeds or the first leaves are being produced, the range must be lightly grazed. Provided it is not done at these critical times, grazing grass twice or even three times a season does not hurt its vigor. Too early grazing increases the death losses from poisonous plants, since many of them appear before other foliage and grass in the spring.

Grass seeded on such slopes performs the double service of holding the soil and feeding cattle.

Another phase of the grazing problem deserves study. There ought to be enough on the prairies and plains and in the forests left over from the grazing industry to provide grass and browse for wildlife. Elk, antelope, mountain sheep, and deer need only a little left for them, but they return much in recreation. Severe competition has arisen between deer and livestock on the Kaibab plateau in Arizona, and between elk and livestock in the Jackson's Hole area in Wyoming. Care for wildlife must be definitely included in our plans for the future. Leavings are not enough. It should be assigned a place at our grazing table. There ought to be, also, nesting cover for waterfowl and upland game birds.

Grassland Regulation

The difficult problems of maintaining our grass resources in best condition all point to the necessity for range planning and grazing regulations.

The first legal restrictions on the use of the range came with the establishment of the National Forest Reserves in 1891. Stockmen were forbidden use of the reserves for any purpose. Actually, however, the men who were using the summer range for some ten million head of stock were little affected, since the law

Management of grazing in the national forests first taught the wisdom of conservation of grass. Some grass is left for insurance against a poor crop the year following.

was not enforced. But in 1905 the Forest Service began enforcing the law and stockmen raised a roar that reached the capitol. Although stockmen did not own the land, they had been using it for years and felt they had a right to continue doing so. The sudden stoppage of their summer range might have meant the ruin of their business. Congress amended the law in 1907, to form the first systematic control of livestock grazing in the United States.

It undertook to regulate summer grazing in the national forests. This system has now been working successfully for more than 35 years and is a very good example of what can be done to protect the range and increase its carrying capacity.

A detailed survey of the range is first made to determine how many head of each class of livestock can be safely carried

on each portion. Ordinarily it has been found that the number which can be grazed to best advantage is almost always far less than the number actually being grazed. Owners are then given time to make the necessary reduction in their herds to keep the range from remaining overstocked. All farmers, not primarily stockmen, who live near the forest are given free grazing for their farm animals. Stockmen who live near the forest are given next consideration. Each must have a permit for the number of stock he intends to graze on the forest. He pays a specified fee

Grassy cover gives small game and birds a chance to live.

for each animal. He also agrees to observe the regulations which aim to protect and improve the range. When a man is assigned a certain area, he is notified of the earliest date he can put his stock on the range. Thus, the grass is allowed time enough to be ready for the cattle when they come. Any racing for the range is unnecessary, because each owner is assigned a definite area. The owner notifies the ranger when he wishes to enter. The stock pass through a narrow chute and are counted as they enter the range. In case the tract is located far in the interior of the national forest, a lane several hundred feet wide is marked and the stock are driven through. A time is set for passing through this lane to prevent one man from grazing his stock on another man's land while he is going to his own area.

Still other regulations must be observed. For example, sheep may not be bedded in the same place more than three nights.

Following the Government's plan, associations of cattlemen in the West decide on the number of head that can be grazed, and where and when they may be pastured. Only a prescribed number of sheep and cattle are allowed on a range.

This precaution prevents all vegetation from being eaten. Blocks of rock salt, usually called "salt licks," are placed at designated spots. All animals crave salt, and if it is placed near water, cattle are likely to stay near-by. When salt is placed on the hillsides, it lures them up into areas they would not likely graze. Salt thus encourages stock to cover more of the range.

In return for the grazing fee and obedience to these grazing regulations, the Forest Service eradicates poisonous plants or fences off the areas where they grow. In addition, water holes and springs are cleaned out and fenced; watering troughs and windmills are set up and many acres more are made available by supplying a constant supply of good water. Professional hunters are hired to shoot and trap wolves, bears, and mountain lions that prey upon stock.

Studies are made of the character of the range. Each tract is assigned to the type of stock to which it is best suited—grass to the cattle, and weeds and browse to the sheep. In addition, studies and experiments in range management are made to deter-

mine the best method for keeping the range producing at its peak. It was found that the range could be greatly improved by forbidding grazing at certain times of the year. Annual plants can stand heavy grazing in the spring and early summer; but, if they are to persist from year to year, the stock must be withdrawn in the late summer to allow the plants time to ripen their seed. Stock may again be returned to the range to feed upon the remaining vegetation. This arrangement both reduces the fire hazard, and insures the tramping of the seed into the ground where it will be ready to germinate in the spring. Under careful management the range in national forests has been improving.

The success of the Forest Service in the national forests has caused others to try regulated grazing. Grazing associations are being formed in several western states. Nearly 200 were formed in Montana by 1936 to save the rapidly shrinking feed and water supply. The older associations are now on their way to a good, permanent range. Many ranges so managed are showing some improvement.

One area in particular which 20 years before had carried ample feed for six thousand head was supplying barely enough for 2,300 head. Fifteen ranchers decided to graze their cattle cooperatively. They allotted a definite number of head to be run by each member. Next they constructed 60 reservoirs to maintain a good water supply.

The Federal Government has set about to develop a wise land program that will be workable for the grasslands of the western prairies and plains. Through many western states, land is being bought by the Government under the provisions of a law which allows the purchase of submarginal land to "adapt this land to its most beneficial use." In the main, it is buying the broken-down farms of men who failed to withstand the drouth, dust storms, and crop failures of the Great Plains. Land that once earned good profits before it was seeded to crops will be turned back for grazing. The Government believes that returning this land to large grazing areas will put it to its best use. Quarter-sections and sections once dealt out in homesteads are being returned to range. On hundreds of farms, houses and barns are being torn down, and fences are being removed. The stockmen smile. This is cow country, and they are happy.

Woodlot grazing destroys young trees and at the same time provides very little food for stock. On the left, seedling trees have a chance to grow into usable size.

These cultivated areas will then be reseeded to native grasses. In places where the water seeps from the ground, concrete storage tanks will be provided to catch the flow. Streams and coulees will be dammed and wells dug. The carrying capacity of the resulting grasslands will be determined and the pasture rented to stockmen. Where possible, the new range will be shared jointly by individuals in grazing associations. Thus the land will return to its original job. The soil will be protected and remain productive.

The Federal Government made great progress in the conservation of grasses when, after many years of effort, it passed the Taylor Grazing Act in 1934. It provides that grazing on the public domain is at last to be regulated completely. Up to 80 million acres of public lands not already allotted to national forests, parks, monuments, or Indian Reservations can be created into grazing districts. The Secretary of the Interior will manage the resulting public ranges to best serve the interests of national

conservation and the livestock industry. He will designate the number of cattle and sheep and the seasons when they will be permitted to graze on any grassland. Watering places will be developed and soil erosion work practiced. Settlers owning land within the borders of the public range may exchange their land for federally owned lands outside the district.

Restoring the Grasslands

All this reconstruction is but the start of building back the grass resource which is the basis of much of America's great livestock industry. Years of hard work will be necessary to rebuild grasslands that will benefit future generations. But not until every parcel of land in the whole country is performing the job it is best fitted to do will the country reach its peak of prosperity.

Land fit for growing grass can be kept in grass. It is a renewable resource just as certainly as the forest is. Grasslands completely destroyed require a long time to be restored. Given some

Where grass grows on hillsides subject to rapid run-off, furrows plowed on the contour hold water. Erosion is prevented and moisture stored.

help, their renewal can be speeded up. Fortunately, most grasslands are not altogether destroyed. In most cases they have been badly injured. With a rest from overstocking and early grazing, they will spring back to greenness with the certainty that has caused grass to be called immortal.

Since grass is a renewable resource, it should be cared for on a sustained yield basis. Every year it should grow just as much as is taken from it. Year after year it must remain as productive as before. Had this law been practiced in days gone by, we would not have seen the sad happenings of the Great Plains, where people were forced to move after working their whole lifetime to found a home.

A sustained yield of grass, for example, would not have permitted plowing of the land around a small city in Kansas. Until the drouth, it had a population of around five thousand, and was thriving. A few years after the rains failed, the city consisted of the railroad station and a Harvey eating house alone on the plain, with useless lamp posts and fire hydrants scattered for blocks around as the only evidence of its departed glory. The original city might have been supported securely if its living had been based on a sustained yield from the surrounding grasslands.

Grass that is managed on a sustained yield will provide forage for livestock and homes and food for wildlife. It will protect watersheds from eroding and dust storms from clouding the air. It will save dams from being filled with silt. It will provide a continuous living for the people who manage and care for it.

In the study of our grass resources, we have talked about grass on the range where it is most abundant. But everywhere, the grass about us is important. Whether it be the neighboring pasture, the idle land down the road, or the city park, grass deserves good care to keep it productive. Grass along the edge of the road helps to keep down dust and, if high, furnishes wildlife a quick escape from danger. Perhaps some seed sown along the road will give grass a better chance.

Vacant land is never idle when it is covered with grass. The soil is gathering food to produce better crops. Watch for grass along the valleys and banks of a stream. Wherever you see bare

Vacant land is never idle when it is covered with grass.

unprotected soil that may be swept into a stream, you have a duty to your city, state, and nation to see that it is planted to grass.

Grass is the sign of a healthy nation. Grass-covered slopes and plains are proof against the disease of erosion. There will be no symptoms of dust storms, muddy water, and silt-filled streams and reservoirs. Grass will heal gullies and cover the scars with its green mantle. Grass will help to keep America healthy.

REVIEW QUESTIONS

1. How does grass keep a nation healthy and prosperous?
2. Of what kinds of land does the range consist?
3. How have prairie grasses protected the soil? Why will many of the prairies likely never again be used for grass?
4. What kinds of grasses were important in the Great Plains area? Over what states were they distributed? Locate and describe the semi-arid range country.

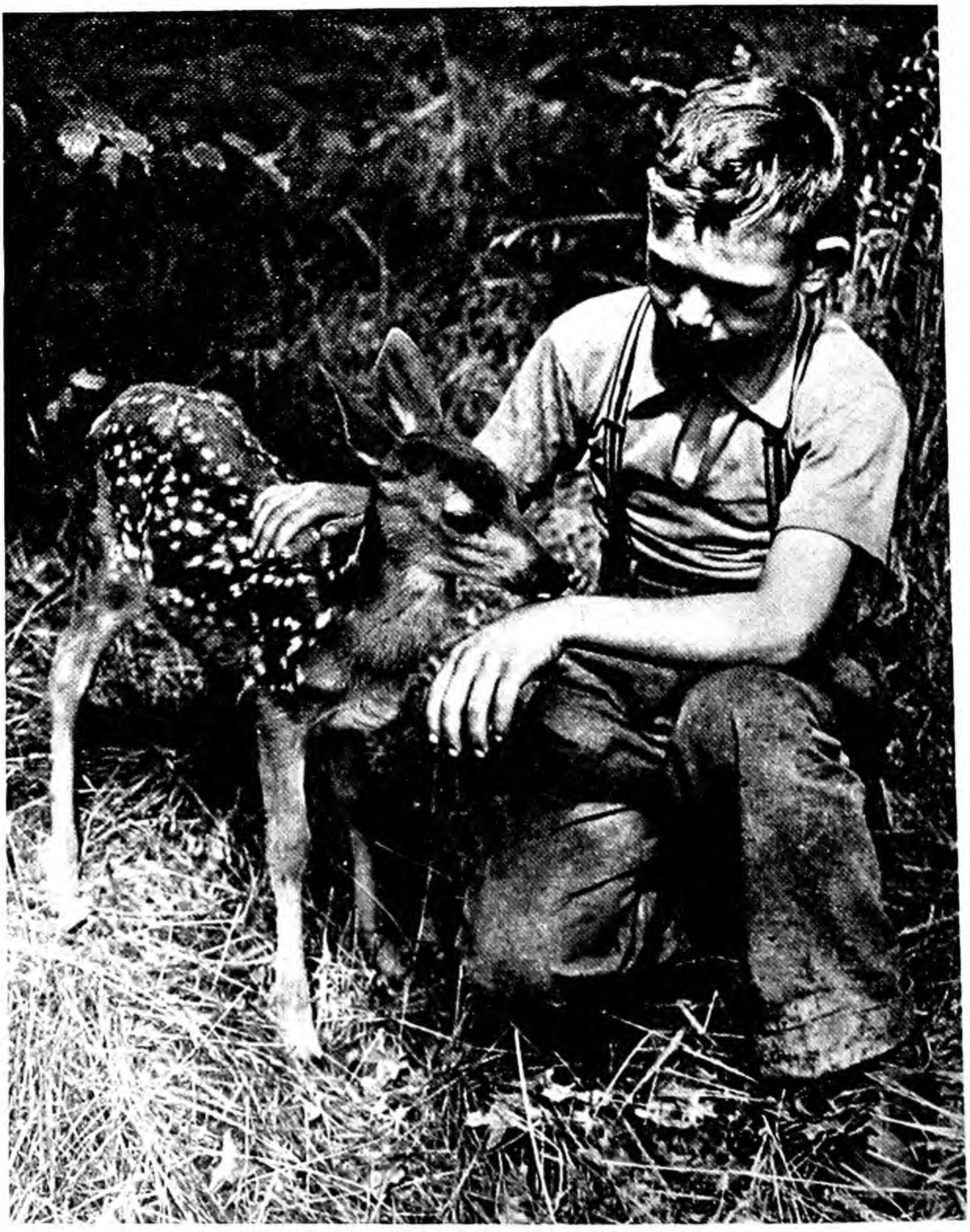
5. What factors encouraged the range cattle industry?
6. How did the wars over the range affect the grass resource?
7. What is the relationship between the first World War and dust storms?
8. What are the principal causes for depletion of the range?
9. What is the present character of the western grasslands?
10. In what two ways does overgrazing affect livestock? What is its harmfulness to the soil?
11. What features should go into a perfect grass for the prairies? For the plains? For the semi-arid areas?
12. How can the grasslands be made to carry stock through wet and dry years?
13. Why has the regulation of grazing in the national forests been important elsewhere?
14. What rules have been found wise in preserving grass in the national forests? List those which might be suitable for conservation of the prairie and plains grasses.
15. How is land being zoned and put to its best use in part of the grassland area?
16. What are the advantages of managing grass on a sustained yield?
17. Why is grass said to be the sign of a healthy nation?
18. Which grasses will be best suited in your locality to hold down sand dunes and prevent the blowing of soil? For halting river-bank erosion? For roadside planting?

SUGGESTED ACTIVITIES

1. Study from reference books the story of how a particular grass was domesticated to become a crop. Which of the wild grasses may be so improved?
2. List the common grasses in your region. Specify the characteristics of each one, and show its particular values. Make a collection of the chief grasses of the prairies and plains and the southwest range. Learn to identify ten of the most common ones.
3. Make a survey of the grasslands near your home. What is each being used for? Could it be more wisely used? Specify what the best use might be for each plot.
4. From government records you can find the number of cattle which grazed on the western ranges for each ten years since 1870. By means of a diagram illustrate what you discover.
5. On an outline map locate the great areas where grass has been of greatest importance. Draw lines showing rainfall. How much rainfall is required to grow a good crop of wheat, cotton, corn, and tobacco? Which regions would seem to be best zoned for grazing?
6. If you are near some grazing land, look for evidence of overgrazing, of too early grazing, and of poisonous weeds. You might make suggestions for correcting the misuse.

7. Dig up a piece of sod six inches square and weigh it. Then wash all the soil off the roots and weigh again. How much soil was held by the roots? Study the root systems of several native grasses.
8. Plant several small beds of grass. Observe how long it takes the seed of each species to germinate. On the basis of what you find, decide which grasses will be best for immediate cover.
9. Measure what is the effect of clipping old sod and a new planting. How often can grasses be grazed without harm?
10. Plant a river bank to grass. Use a vigorous grass to plant roadsides that might gully.

Debate: Resolved, That for permanent improvement of the range, attention to reseeding is more effective than reducing the numbers of livestock.



"It is strange how little has been done since the Bronze Age in taming, using, befriending, and appreciating the animal life around us."
—H. G. Wells.

CHAPTER SEVEN

Conserving Wildlife

TAKE A WALK through the woods some early spring evening. If you keep your eyes and ears open, you will see or hear many creatures that make up another of America's great sources of wealth—wildlife. The cheerful whistle of a bobwhite from a near-by patch of weeds, the drumming of a ruffed grouse in a thicket, the distant gobble of a wild turkey and the call of wild geese overhead are all a part of wildlife.

If you crossed some creek in your walk or passed a lake, perhaps you saw minnows in the shallows and a larger fish leaping for flies. If you were very lucky, you may have glimpsed a muskrat at work, or a skunk ambling down the road ahead hunting a meal of ants, mice, insects, or turtle eggs. Wildlife includes the feathered, finned, and furred inhabitants of the woods, fields, lakes, and streams.

Wildlife has helped to write American history. The early colonists, after a long voyage across the Atlantic, reached American shores almost without food. When they found great forests full of deer, moose, partridges, wild turkeys, ducks, and pigeons, they felt real cause for thanksgiving. In early diaries, explorers tell of trout, river shad, herring, bass, pike, and leaping salmon so abundant that they could be scooped out of the water with little effort. Wild game and fish provided much-needed food for the pioneers.

But, as important as were the deer, turkeys, partridges, and other food animals and birds in the lives of the colonists, the furbearers such as beaver, muskrat, mink and marten, exerted an even greater influence in the history of the country.

For many years colonizers looked for some product to exchange for European goods. The Spaniards had discovered some of the gold that had lured them to the Americas, but French and English traders found far greater gold in furs, which for long were a chief item in trade. Furs, once worn only by nobility,

though still costly, became so plentiful as to be within the reach of everyone. Companies were organized for exploiting the trade. The Hudson's Bay Company, still one of Canada's leading mercantile establishments, was originally formed to trade in furs. The search for furs lured early explorers into the dark interior. Radisson and Grosselliers made their way by canoe from Montreal to Lake Winnipeg and on to Hudson Bay in 1563, years before there was a single white settlement in what is now the United States.

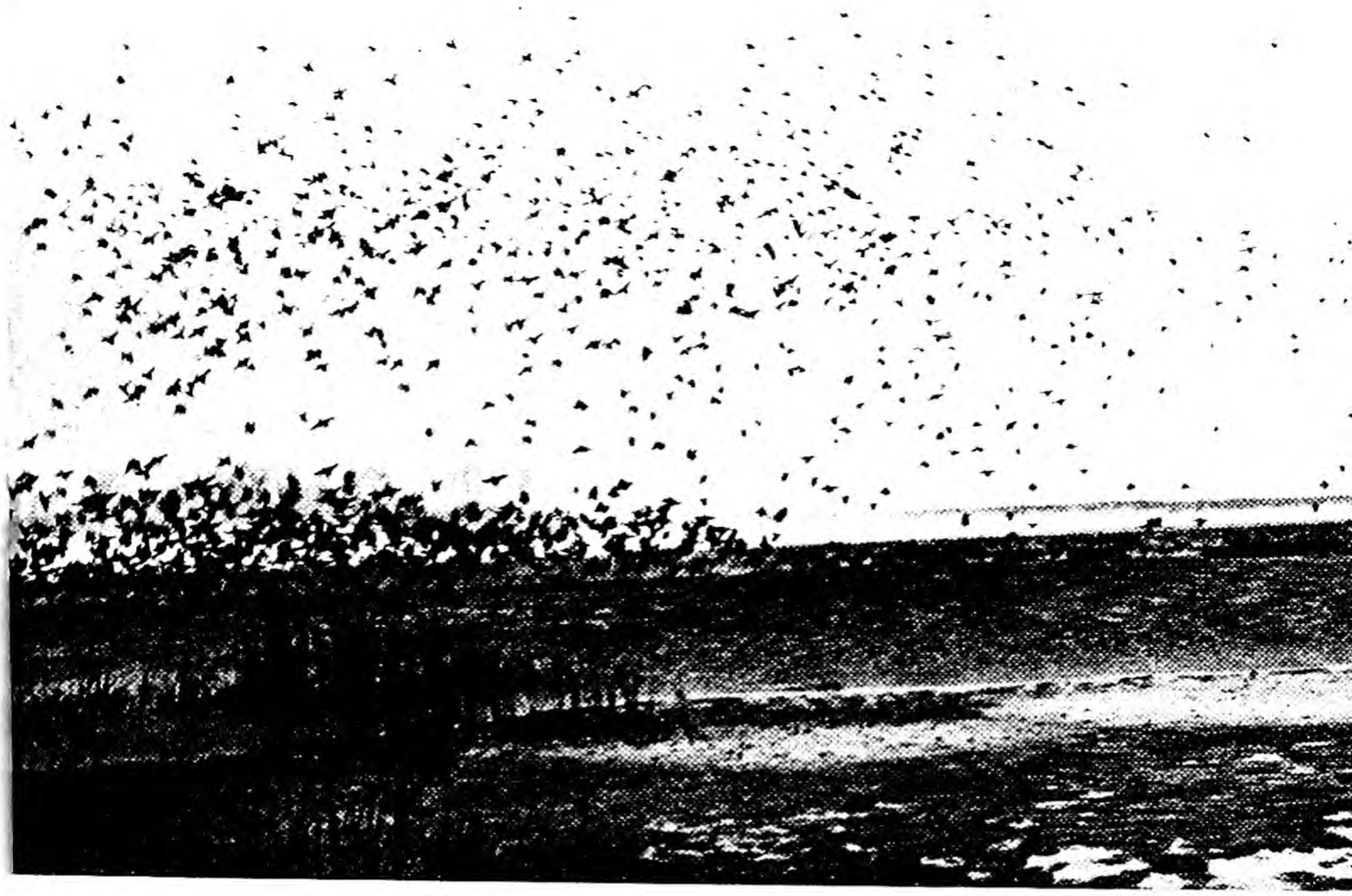
Disputes over fur-trading rights led to the French and Indian War. Furs have been an important consideration in the great territorial acquisitions, such as the Louisiana Purchase and the purchase of Alaska. When trapping is good, Alaska repays more than half of her original purchase price every year in furs alone. Since 1867 more than eighty million dollars' worth of furs have been sold from that territory.

When white men first reached America, it was perhaps the richest country in the world in wildlife resources. If an inventory of wildlife wealth had been made at that time, it would have included great herds of elk roaming over most of the prairies and forests. Deer, and, in the northern forests, moose and caribou, were plentiful enough to supply the Indians with much of their food. A settler had to go only a short way to get meat enough for the week. Hunters made their living for years supplying the lumber and mining camps with venison.

Scattered over the grasslands of the United States were gigantic herds of buffalo, perhaps as many as sixty million head in all. As they slowly moved northwards, a single herd was sometimes fifty miles wide, and looked like a rolling sea of brown humps, said early settlers. The antelope on the prairies and plains was almost as abundant.

Fur-bearing animals seemed unlimited in the American wilderness. Indians brought in thousands of pelts of incredible value, gladly exchanging them for a few glass beads, a piece of bright cloth, a cheap steel knife, or a battered gun. Fox, fisher, marten, weasel, raccoon, wolverine, opossum, wild cat, lynx, wolf, bear, and skunk abounded.

The swamps and marshes, now too often regarded of little value, contained the greatest wealth. Muskrats, mink, otter, and



Ducks and geese once clouded the air.

beavers were there in countless numbers. Every child knew where to look for an otter slide. Beaver skins were so plentiful that they were used instead of money in many frontier districts. Men did not ask the price of flour in dollars but said, "How many skins for that barrel?"

In addition to the furs, the marshes yielded waterfowl of all kinds and wild rice, hay grasses, and food to support the wildlife. It is said that slaves were fed canvasback ducks until they revolted. For a fall Sunday dinner it was easy to go out and get ducks, wild geese, and often turkeys.

A Wildlife Inventory

What would an inventory taken at the present time show? Where have there been losses, and where gains? In almost every column, present figures show wildlife to be dwindling.

The buffalo, for example, has been slaughtered until it is extinct outside of refuges except in far northwestern Canada. Once these bearded animal giants of the plains grazed most of the West from Mexico far up into Canada. But hide-hunters

traveled constantly behind, killing and skinning them, and leaving their flesh to rot. One hunter made $10,000 in less than a year. William Frederick Cody, after winning his title of "Buffalo Bill," escorted hunting parties of wealthy easterners out to the great herds where they could take part in the massacre.

It became a popular sport to shoot buffalo from the windows of railroad coaches as the poor animals raced madly alongside. At least a tenth of a million were killed just for their tongues, which were thought to be a great delicacy. Men with more conscience took the rear quarters, the tongue, and a few strips of hump. All the while the Government did nothing to prevent the shameful butchery, believing that the troublesome Indians could not be controlled until their great source of food, the buffalo, was gone from the plains. How completely they were removed became apparent when settlers began gathering the bones together by the ton to be shipped to Minneapolis to be converted into fertilizer.

The dreadful toll reached more than one million animals yearly. Luckily, a few were rescued and are preserved in semi-captivity where they are thriving and multiplying. Settlement of the prairies robbed other large game of its home and food.

Of some species of our wildlife not one lone straggler now remains to tell the sad story of its decline and death. Not long ago wild passenger pigeons clouded the sun in their migration flights. Stories told about them frequently sound like the yarns of Paul Bunyan, the legendary hero of the north woods. So thick were the flocks that the branches of oak trees snapped under the burden of nesting birds. Herds of hogs fattened on the fallen eggs and young. Hunters followed everywhere the passenger pigeon went. In one small Wisconsin town, near which there was a pigeon rookery, sixteen tons of shot were sold to pigeon hunters in a single year. From one town in Michigan three carloads of dead birds were shipped to market daily during the nesting season. They brought as little as a penny apiece. As the pigeons roosted in trees at night, men crept up with clubs and nets, stunned and killed the birds. Often, wagonloads of them spoiled before reaching market. When wildlife is hunted day and night, it is given no chance to rest. Night hunting used to leave a great waste in crippled birds that were not recovered.

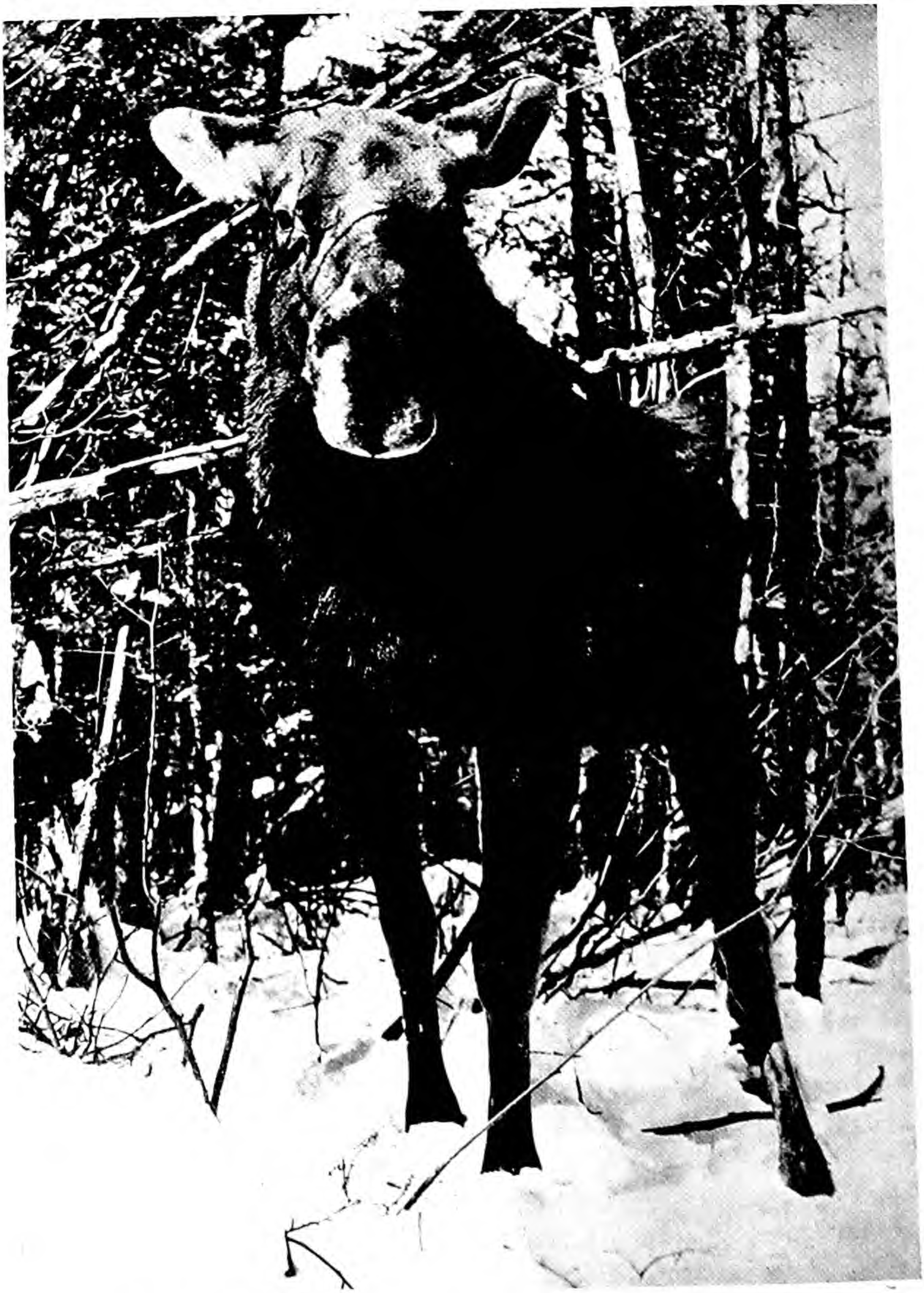
Under such wholesale murder the numbers shrank to only a few, and finally in 1914 the last pigeon died in a Cincinnati zoo. The heath hen, Labrador duck, and perhaps eight other species have also passed into history, while no less than fifteen others are facing extinction.

Although only a few species have been completely killed off, most wild creatures have been so thinned by mankind that

All that remained of caribou in the United States were three cows in northern Minnesota. The Government has tried to increase their number.

they are now only rarely seen. Antelope, mountain sheep, mountain goats, and caribou are found in greatly reduced numbers. Of these, quite possibly the caribou faces early extinction within the United States. A small herd is being closely observed near Red Lake in Minnesota, but apparently illegal hunting is taking its toll. Only three old cows were left in the herd until nine young animals were recently introduced from Canada. Bears, never present in great numbers, are now found in only a few places.

The shy moose, once plentiful throughout the northern woods, have been pushed back into the mountains and a few wilderness areas. Except in rare places, the majestic elk no longer roam the woods and plains; yet a roadside ditch in Minnesota was recently cut through a solid pile of elk bones.



The moose has been pushed far back into the wilderness.

After more than two hundred years of trapping, fur-bearing animals are now of lessening importance. Many species, unless given particular help, may become extinct.

Deer have fared well, adapting themselves to the demands of agriculture.

On the brighter side of the account book, there can be placed only a few species of wildlife.

Deer have fared well. They seldom gather in herds, but travel singly and in pairs, thus making their destruction difficult. Stringent laws have been in force protecting them for many years. Another reason that deer are becoming increasingly plentiful is the growth of tender underbrush that has followed the

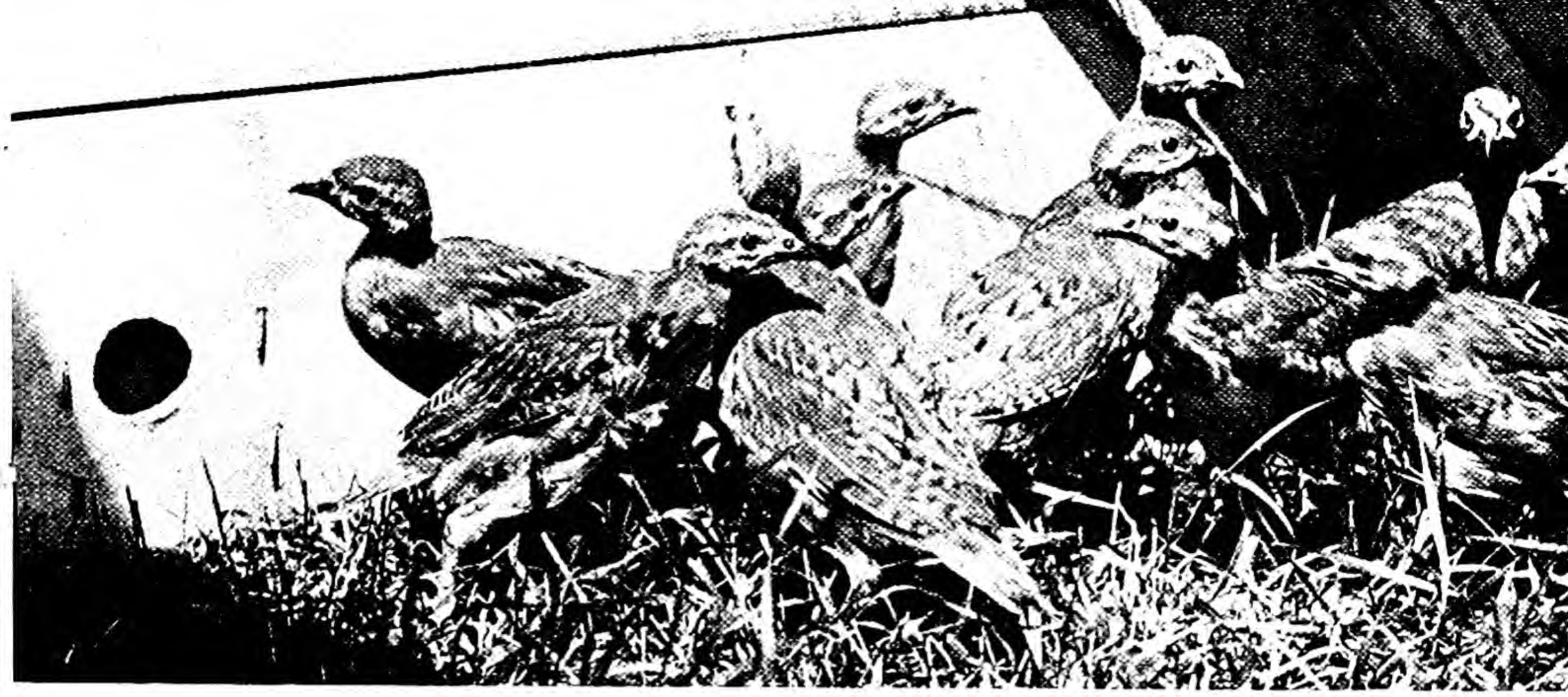
clearing of large stands of virgin timber. The young growth furnishes just the browse that they need the year around. Deer seem to fit better into present conditions than other big game.

Most song birds have increased with the approach of civilization. The robin, purple martin, and a great many others thrive about city parks and on farms where any encouragement is given them. If a feeding station is built outside a window, a few pounds of sunflower seeds will soon attract more birds than can usually be found in a dense forest.

Small birds and animals, with protection, have been able to hold their own.

In our account book, we must make a special classification for the so-called "exotic" wildlife. Exotics are importations of species that are not native to this country. The pheasant is an exotic from the Orient; it promises to be a major upland game bird, particularly if the native birds continue to lose in their fight for life. The Hungarian partridge, recently introduced, shows some promise of success. The chukar partridge, coming from India, may prove hardy in some regions.

Great care must be used in introducing exotics, since it is hard to predict what effect a new species will have on the native supply. The English sparrow and the starling are both exotics that have earned the name of public pests. The carp, a fish from Germany, multiplied so rapidly after importation that it is displacing many fine game fish. The carp is a rough fish, thriving in muddy, polluted water and changing our clear lakes into muddy ones. When the muskrat was sent to Europe, it became a pest.



The chukar partridge has been introduced from India. Great care must be taken not to introduce harmful exotics.

In most cases it is far more sensible to take care of the native species that are known, than it is to introduce exotic species about which little is known. There is the chance that new diseases may be introduced with new species.

Causes for Decline

Let us now look more closely at the story behind the nation's great losses in wildlife.

When virgin forest, prairie, and swamp are transformed into farmland, the day-by-day existence of wildlife is thrown into confusion. The larger game, particularly, begins to disappear. According to the United States Biological Survey, nearly all birds up to the size of a crow, and of mammals to the size of a rabbit, increase during the first stages of agriculture. But, when farming becomes more intensive, when thickets are cleared, hedgerows grubbed, and forests and grasslands burned, even the smaller game must retreat or die.

As civilization expands it destroys the feeding, resting and nesting spots of our wildlife. Shy game like the moose and caribou go farther and farther into the wilderness. Eventually they are pushed against a boundary beyond which they can not live. Smaller game must hide in thickets still unploughed, in weedy fence rows, and in waste swamps. Gradually wildlife has become "a product of edges," of the border lands.

Draining and pollution of our waters have caused great shrinkage in the area available to wildlife. When America passed

through the recent craze of swamp draining and land reclaiming, it destroyed the nesting sites of many thousands of our waterfowl. Bogs are still burned every spring just when wild game has begun to build homes.

As the nation grew, wildlife was pushed into the edges, into thickets still unploughed, into weedy fence rows, and into waste swamps. Disease has attacked many species. The rabbit needs protection when its numbers are badly thinned.

Oil discharged from boats, and sewage from factories and cities have polluted streams and lakes. The feathers of ducks have at times become so saturated with oil as to make flying impossible. Sewage draws oxygen from the water when it decomposes, and fish die of suffocation.

Careless farming and unwise cutting of forests have brought on soil erosion further to destroy the clear lakes and streams, making them unfit for wildlife. All the problems of conservation are so closely inter-related that one can not be considered without giving attention to others.

It has been estimated that speeding automobiles each day kill approximately 7,000 birds and mammals in the United States.

Wild birds in their migrations suffer great losses from poachers, and from flying against overhead wires.

As long as man hunted with bow and arrow and used his game for his own food only, there was no lessening of the supply. But, when firearms came into general use and professional hunters began to supply eastern markets, game began to dwindle. It is hard to conceive of market hunting today, after being accustomed for a long time to laws prohibiting it. But formerly game was thought to be limitless. Chicago became the greatest game market in the world. Bear and deer hung from hooks like beef. Quail sometimes sold two for five cents, prairie chicken for a nickel, and ducks like ordinary poultry. From 1873 to 1886 these prices per dozen were quoted in a Chicago paper:

Woodcock	$3.00	Partridges	$2.25
Prairie Chickens	3.50	Jacksnipe	2.25
Mallard Ducks	3.00	Quail	1.37
Canvasbacks	6.00	Wild Geese	4.50
Teal Ducks	2.00	Turkeys	$1.00 each

Another cause for the diminishing wildlife supply is the diseases that periodically attack certain species. Pollution of water and concentration of creatures into small reserves have increased disease danger. It was recently noticed that many ducks were dying in some of the best duck lakes. None of the usual diseases that commonly affect ducks seemed to be present. Instead, they showed every symptom of poisoning, which is unusual in wildlife. Ducks that fed on the bottom of the lake were especially affected. After some study, the cause was discovered. The bottom of the lake was literally paved with shot from years of shooting. The ducks had scooped up the shot with their food. Their craws were full of it and they were dying of lead poisoning. Lately an alloy of lead and magnesium that rapidly falls to pieces in water is being studied as a possible remedy for the poisoning.

Some of our game belong to what are known as "cyclic" species. The rabbits, prairie chicken, sharp tailed and ruffed grouse are good examples. They build up in number sometimes for from seven to ten years and then die off by the thousand. The cause is believed to be a disease of the liver producing "shock disease." Animals that are affected can not stand exertion. There are a great many other diseases including tularemia, carried by

the ticks on birds and animals, and infesting man. Unless certain species of wildlife are protected when they are at the bottom of the cycle they will be very slow to recover, and may die out altogether. Every real lover of wildlife must be prepared to defend birds, fish, and animals, and be ready to tell why they should be conserved.

Balancing Nature

Perhaps you might tell a farmer that a crew of laborers wanted to come to clear his farm of insect pests and weeds. He would likely be pleased, but wonder what it would cost. "Only their room, and now and then a scanty meal," you could answer. For that is all that birds need—a little privacy where they may live and build their nests, and an occasional meal. Government estimates show that the number of mosquitoes killed by a single family of barn swallows can be of untold importance in making your summer pleasant.

Many young birds eat more than twice their own weight daily in worms, flies, and insects. The picture shows a wood thrush feeding its young.

Some hot summer afternoon watch a pair of wrens feeding their young. If you can station yourself near enough, count the number of trips each parent makes to the nest. After one hour you will be able to understand why the absence of a few families of birds will allow pests to destroy farmers' crops. In the poem, "The Birds of Killingworth," Longfellow tells the story of some townspeople who

Gulls were the answer to the prayers of Mormons in Utah. This young gull is beginning a long life of usefulness.

thought birds were unnecessary and a nuisance. When they killed all the birds throughout the community, worms and insect pests overran the town.

In the early days of the settlement of Utah, "crickets" descended in clouds and threatened to eat all the Mormons' crops. The Mormons were helpless to drive off the pests; they called meetings and prayed for relief. Gulls appeared by the thousands and devoured the crickets. The grateful Mormons erected a monument to the sea gulls, and now it is a grave offense to kill a gull in Utah.

One can have little conception of the seething clouds of flies we would have if it were not for our aerial hunters, the swallows and swifts. A single pair of house flies could produce in one season more than 335 trillion flies, if all were to live.

The suet-eating birds, the chickadees and nuthatches, and the vireos and orioles destroy uncounted numbers of eggs and larvae. The insect-destroying value of birds in this country has been estimated at $350,000,000 a year.

Flies and insects have other bitter enemies—lizards, salamanders, frogs, toads, and, among the most daring warriors, spiders. Toads and frogs, another kind of wildlife always to be protected, seem ever to be on the hop to catch flies and other

The skunk is an able little conservationist and is also a source of fine furs.

pests. When June bugs or grubworms become numerous, toads develop a particular appetite for them and thus control the pest.

Skunks in their hunting through the sand near beaches, keep control over the population of turtles, some of the worst enemies of wildfowl and fish. They are thus indirectly an aid to other wildlife.

Many of the benefits of wildlife then are indirect, distinct from such direct benefits as food and fur values. The direct values, however, are also of great importance.

About 129,000 people draw their living from commercial fishing, and fish products worth $93,000,000 are produced annually. In addition, fishing for recreation requires fishing tackle, fishing clothes, transportation and lodging, items that give employment and income to a great many others. There are as many hunters

and fishers as there are all football, baseball, golf, and tennis fans. Four times as many people went hunting and fishing in 1930 as in 1920. The annual value of meat and furs produced from wildlife in the United States has been estimated at $150,000,000. The most important item is the nation's tourist business as a whole, estimated usually at a billion dollars a year. Fish and game are responsible for a large part of this figure.

Anyone who has caught his first yellow perch in the millpond knows the greatest reason why game fish ought to be protected. The pleasure that tired mankind finds in fishing can never be measured in dollars and cents. Some 11,000,000 men go to the country during the year to find relaxation in angling, the best tonic known for tense nerves.

In addition to hunting and fishing, the true sportsman feels real pleasure merely in seeing wildlife abundant about him. The honking of a flock of wild geese overhead can tinge a whole day with excitement. Watching a family of loons can make an otherwise dark afternoon one of the pleasantest in memory. At the writer's cabin in the woods the day's work is never complete until the raccoon's pan has been filled. The mother raccoon never fails to clean up its contents; nor does an evening very often pass when some member of the family does not watch her when she brings her babies up from the swamp and lets them watch her eat.

Preserving wildlife is the task of everyone who glories in the out-of-doors. In Europe, since time immemorial, hunting rights have always belonged to the nobility or the landowners, and have been protected by them. In democratic America, it can be a source of pride that the courts have ruled that:

"Wildlife is held in trust by the State or Federal Government for the benefit of all citizens and does not become the property of the individual until reduced to possession in a legal manner."

Wildlife, thus, is owned by the public; no one is entitled to own or claim animals without official permission. Wildlife is held in trust just as are the public roads, and we are entrusted with its proper care and conservation. There are stringent laws for the protection of desirable birds and animals; but, as it is impossible to detect all violations, they are left in some measure to public sentiment for protection.

Beginnings of Wildlife Conservation

For a great many years, conservation meant nothing to American pioneers busy at conquering the wilderness; they had no time to observe the effects of exploitation on food and fur-bearing animals. As the country developed, too, men found time for leisure. For recreation they took quite naturally to fishing and hunting. But to their dismay, fish no longer lay in the old pools, wildfowl were becoming increasingly scarce, and big game, in many sections, had vanished into the past. Immediately there came a cry for protection of game and fish. Fishing and hunting for sport by this time exceeded the food and fur value by many times. With few persons directly depending upon game and fish for food, there was little opposition to game laws. Most early laws followed the obvious course of limiting the number of animals that might be killed.

When a shipwrecked crew is on a raft at sea with a limited amount of food, the first step is to reduce the rations so that the food will last longer. Laws limited the season at which game might be taken as well as the number to be killed.

These early laws might have worked, since restrictions can be successful. Wildlife is a renewable resource, and, if undisturbed, will usually increase if conditions are favorable. Unfortunately for wildlife, the conditions did change. Hunters increased year by year, and, it has been seen, the homes and foods of wildlife disappeared as settlements pushed farther inland. Just as the shipwrecked crew on a raft will inevitably starve in time with a limited ration, so game finally dies out when nothing is done to renew food plants and cover.

If conservation meant that each year fishing and hunting seasons were to be made a few days shorter, and that limits were to be made smaller, the outlook for recreation twenty years from now would be dreary. And yet for a long time conservation was just about that—a story of increasing restrictions.

But conservation of wildlife has become much more. Laws will not plant food nor bring back suitable homes. Drained swamps can be more disastrous than a hunter's gun. Game managers are teaching how to restore, as nearly as possible, the surroundings that will best favor a good crop of wildlife.

This 33-pound muskellunge, speared through the ice in a Minnesota lake, contained thousands of eggs that would have helped preserve the species. Winter fishing must stop.

Exact Knowledge Essential

The best first approach to restoring wildlife is to discover the food and living habits of each species. The food habits of fish have been learned from a study of the contents of their stomachs.

Lakes are checked for depth, temperature, and type of bottom. A fish census will reveal whether or not the lake is overstocked.

Their nesting and egg-laying habits have been observed, and the distances they travel have been learned by netting and tagging. Bass, bluegills, and crappies, known as warm-water fish, were found to build nests, deposit their eggs, and stand guard until the young hatched, which was usually in about two weeks. The parent fish guards the school, conducting the minnows around the lake in search of food. Some trout, it was found, spawn in the fall; others in the spring. Some fish spawn requires salt water; other spawn must be kept in fresh water. About 150 days are needed for hatching whitefish, herring, and lake trout eggs. The mackerel hatch in five, and the cod in two to three weeks. Small fish live on the yolk of the eggs from which they hatched and which are attached to them for several days. Many can be fed on beef liver or beef hearts and other meat diets.

Other fish studies have included mapping lakes carefully to show the zones of depth, the zones of vegetable and animal life,

the temperature at different depths, the character of the lake bottom, and a chemical analysis of the water. A census can be taken of the fish population. With this information, it is possible to predict just what kind of fish, and roughly what numbers, can be supported in each lake or stream. Bottoms may be improved to support more fish. Enough work has already been done to show the value of such studies.

In the same way, research has been applied to bird life. Detailed studies, although worked out for only a few species, have added much to our knowledge of birds.

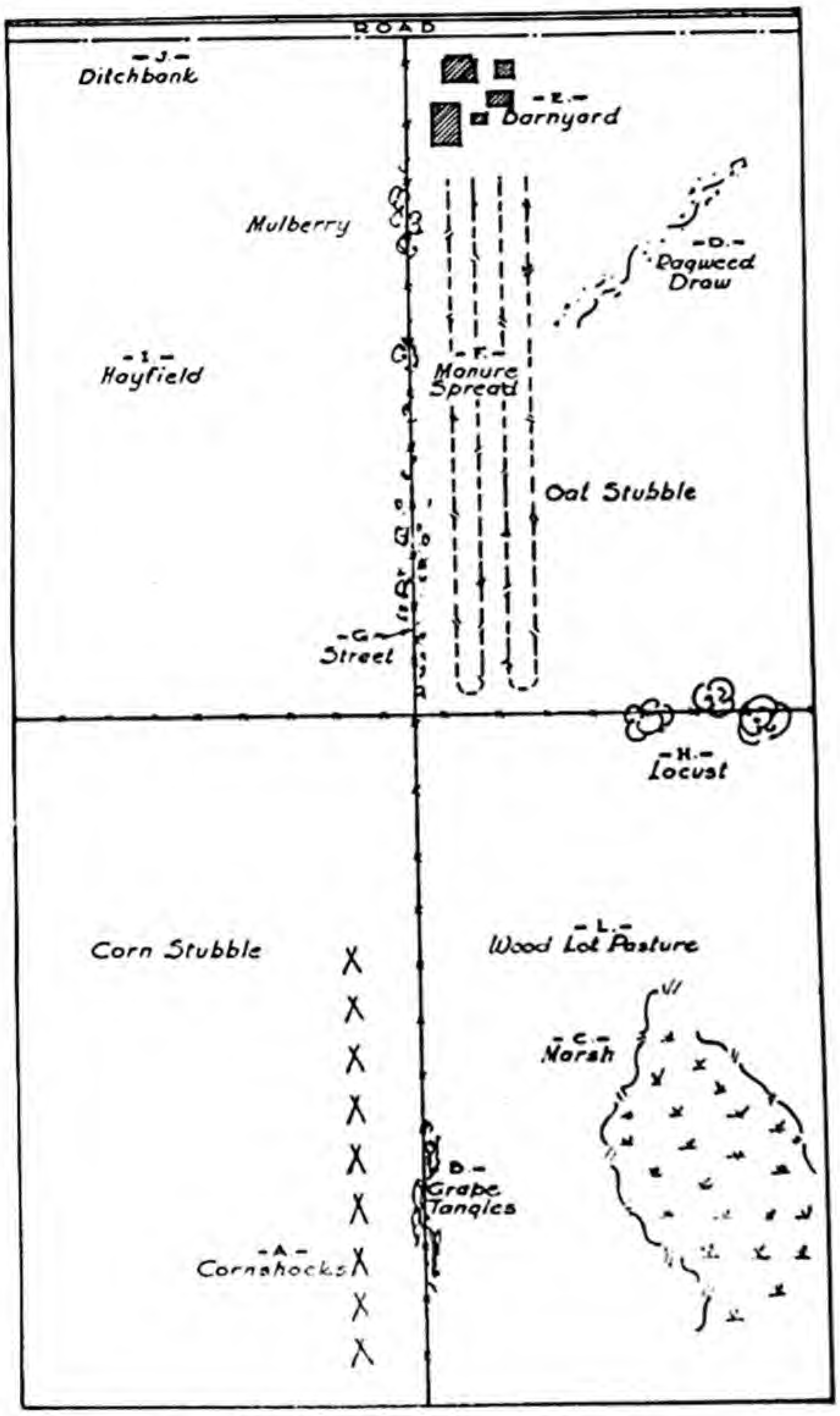
Dr. Ralph King has studied conditions required by grouse. These are hard to discover, since game birds are usually very shy, hard to find and observe. To figure the number of males in a locality, he first located several "drumming logs," which to grouse are the center of their kingdoms. The proportion of males to females, he knew, ran half and half. He located as many nests as possible and visited them daily. When hatching time neared, he placed a hardware-cloth fence around each nest to prevent the young chicks from leaving. On hatching day, he fastened a numbered surgeon's clip in the loose skin at the base of each chick's wing. A record was kept of the numbers and of the location of the nest.

The following winter birds were live-trapped in pens throughout the entire experimental forest. Each bird was examined for its tag, and a record made of the spot where it was taken. In this way the distance each bird traveled from its nest was known. Many grouse were caught in the same forty acres; not one was more than three fourths of a mile away.

Before the bird was released, some feathers in its tail were cut off and colored feathers glued to the stubs. Each color told something about hatching place, age, and sex. A glance at a bird would tell its whole life history. In spite of its extremely rapid flight, a grouse was seldom found to stray more than half a mile from the place where it was hatched. A quail usually spends the entire year within a forty-acre tract. This knowledge means that everything needed to complete the yearly round of life must be found in good quantities within small areas. The distance that a bird or animal travels in search of food, water, a nesting spot, or cover, is said to be its "cruising range."

The following *Biography of a Covey* (of fifteen quail in southern Wisconsin) resulting from a study made by Dr. Aldo Leopold of the University of Wisconsin shows how food and shelter control survival:

January: The covey is feeding on cornshocks which have been accidentally left at (A), using several grape tangles (B) as daytime cover. They fly to the marsh (C) to roost.



Change 1: The ground gets hard so the farmer husks out the shocks and hauls the corn to the barn. His place is posted, and he is a quail-lover, but he is unaware that he is depriving his birds of food. (There is plenty of corn one half mile away, but no cover, hence the birds can't reach it.)

Change 2: A snow buries the ragweed, so the covey begins to fly to the barnyard to feed. The farmer notes this, and feels a glow of hospitable pleasure over his guests. But the farm dog and cats note it, too. The cats get one. Another dies of cold when the dog scatters them late one afternoon, and the bird fails to rejoin the others before dark. Motor traffic gets another. Twelve left.

Change 3: The farmer by accident begins to spread manure on snow in stubble at (F). This is much better than risking the barnyard, so they feed there. Using fence row (G) as a street, they don't need to fly.

February: Every day the manure-spreader moves farther from the fence, while snow covers the near-by manure. A Cooper's hawk happens along and catches the covey in mid-field. He gets one. Eleven left.

Change 4: So the covey must give up the manure. Watched by the hawk it "holes up" all day under the grapes, foodless for two days. They drop in weight from 190 to 170 grams—a large loss in speed and strength.

Change 5: So the third day they stay right in the marsh where they roosted, and find they can scratch up enough dodder, jewelweed, and smartweed seed to live. The hawk gives it up and leaves. But now comes a really deep snow, hiding all the marsh food.

Change 6: They sally forth, forced by hunger, to the locust trees at (H). This is poor food, and uses up nearly as much energy as it gives. Their average weight has now dropped to 160 grams. One night a wandering mink flushes the roosting birds which scatter in the dark. One alights in the open, where a horned owl picks him up. Two others die of cold. Eight left.

March: Change 7: A thaw comes and exposes the old manure near the fence. The remnant of the covey eagerly resumes feeding there. But the farmer now burns the marsh, forcing the birds to roost under the grapes. Here a passer-by flushes them one evening, so late the owl again scores. Seven left, but weight going up. Many migrant Cooper's hawks this month, but on the snowless ground they fail to score on these educated birds of rising weight and strength.

April: Green alfalfa and waste corn have increased weights, and the birds begin to pair on warm days, and look for nesting territories. There are three pairs plus an unmated cock who whistles his disappointment. Those who hear him think it is the mated cocks, but these seldom whistle.

May: The three pairs begin nesting, one in the alfalfa, one in the greening marsh, another on the ditch.

June: A rain drowns the marsh nest, the haymower destroys the alfalfa nest. Both bereaved pairs try again, one in the oats, the other on the ditch.

July: The mower gets the oats nest, but the early ditch nest brings off a dozen young (total fourteen) and the late ditch nest all but four chicks which the cats kill. Total twenty four.

August: Cats, dogs, and cars get four chicks. Total twenty.

September: Easy going, no losses.

October: Eating ragweed and foxtail in corn and oat stubble. A pheasant hunter pots four. Total sixteen.

November: Same. A rabbit hunter pots one. Total fifteen.

December: Easy going. Number of birds at end of year same as at the beginning.

Summary: Each month in the year presents one or more risks of loss by death or moving out. The possible losses are of many kinds, but all depend largely on whether the range offers

the birds a chance to shift their habits so as to circumvent each particular risk. Hence, at the end of the year the range offering good chances will be heavily populated, while the range offering poor chances will be scantily populated.

It is necessary to know just what birds eat. Students of wildlife set out to answer the question. They studied the stomach

Ruffed grouse must have food for every season, nesting and emergency cover, drumming logs, grit and water—all within cruising range.

contents of birds killed during the hunting season. At other seasons they examined birds that had died or were accidentally killed. This method has cleared the reputation of many birds formerly found guilty of eating grain, and convicted a few that had never been suspected of crime.

The food needs of a species throughout the year must be discovered. It is not enough to know that ruffed grouse, for instance, are fond of blueberries and strawberries. These fruits may be abundant in an area where grouse will be unable to live. Berries furnish food for only a small portion of the year. There must be foods for every season.

In addition, the food habits of young birds are very different from adults. Females require special foods when they are developing eggs. Old birds must have gravel for their gizzards. Young birds and old demand water in some form. Young gamebirds as well as songbirds eat enormous quantities of insects, so all these things must be found within the bird's normal cruising radius. A bird will not travel beyond that distance to supply its needs. If any of these necessities is lacking, the bird will simply find another home.

Food supply is not all that is needed. There must be close, protective cover for nesting, for roosting and for protection from winter wind and snow. There must be dense thickets for protection from hawks, open spaces for sunning, and sandy patches for dust baths. If these needs are lacking within the normal cruising range, the area is unsuited, and game will not live there. Flowers and trees also have particular regions suited to their life, and it is only here that they find life possible.

Is it any wonder, judging from their needs, that birds turned loose without regard to habitat fail to establish themselves?

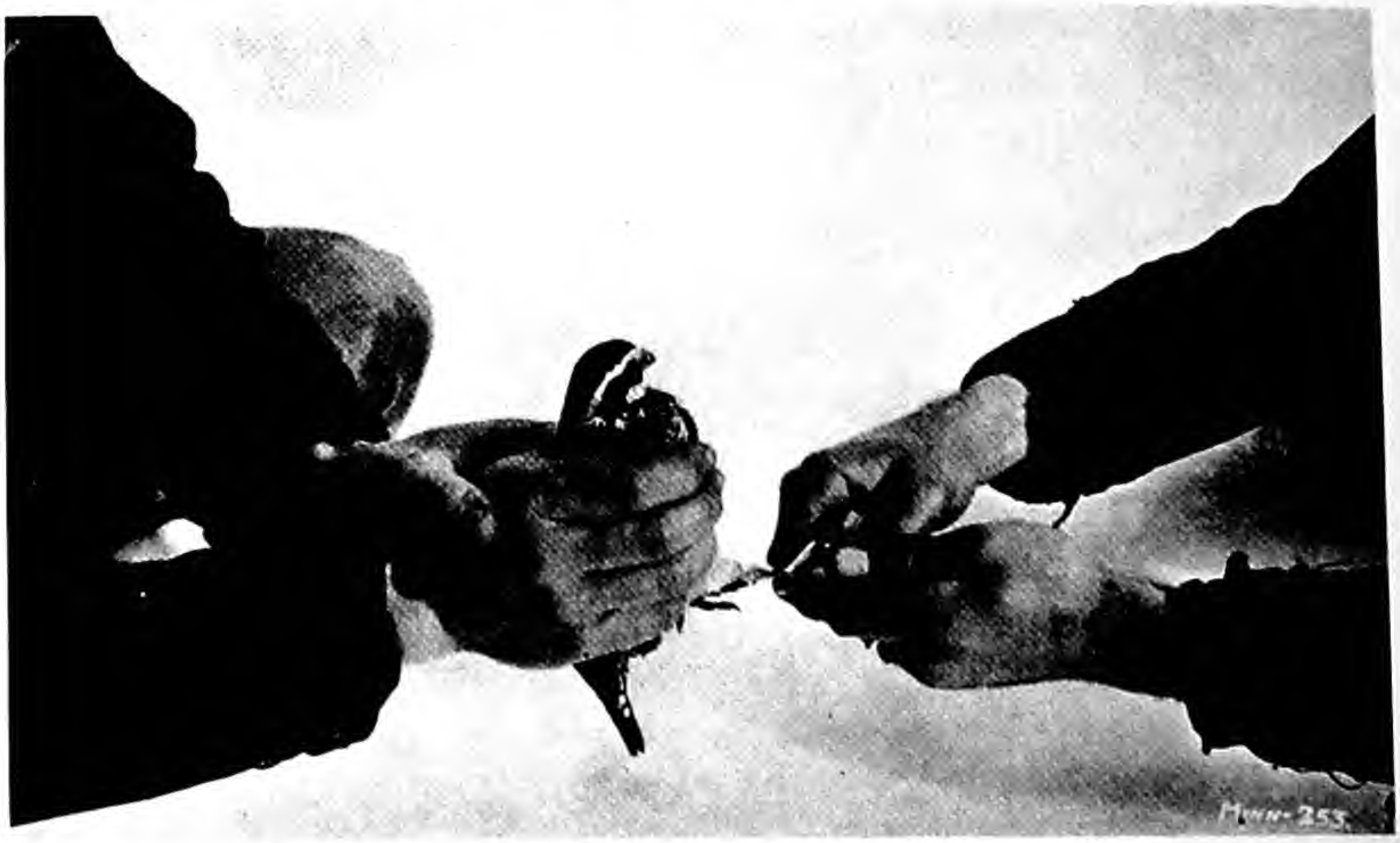
Through bird banding, much has been learned of the strange migrations of certain species. Blue geese, in their journey to the far Arctic tundra, travel by definite routes almost as if they had established highways.

A lighthouse keeper on a lonely Aleutian island observed a gull nesting in a clump of grass not far away. Except when ships landed twice a year, the keeper was all alone on the island, and he naturally took an interest in the gull. In the fall it left for southern South America, where it wintered. For seven years it came back to the same spot, and the date of its spring arrival did not vary more than three days. Imagine a flight of eleven thousand miles and variation of only three days!

Much the same plan as used for birds has been developed in taking the census of game animals. Earlier, men worked on guess alone in determining whether or not wildlife was on the increase. The methods used by timber "cruisers" in estimating lumber in forest plots are taken over into wildlife study. A man runs compass lines through an area, keeping careful watch of all wildlife he can see in a strip in front and on either side of him. Every animal seen is noted, and its distance from the observer is marked

down. The length of the strip is determined by pacing down the lines. From these measurements, the area covered can be calculated, and the animals on an acre estimated for each type of cover.

An animal's cruising range is discovered by attaching an aluminum band to its ear. When a hunter shoots one so marked,



Through banding, men have learned much about the habits of quail.

he sends in the tag, reporting the place it was taken. Strangely, some big game, formerly thought to be great travelers, stayed close to home. The swift-running deer rarely leaves his birthplace more than a few miles. Elk stay pretty well in one locality. Others are great roamers. A moose may travel 25 to 30 miles. Caribou migrate for considerable distances. Fur-bearing animals for the most part stay close to their houses. A yearling bear, caught, tagged, and released, two weeks later was reported shot 25 miles away. Conditions imposed by man or nature, however, may compel animals to make a permanent change of habitat.

When men began to pry into the affairs of fish, they found even greater surprises.

Many were discovered to be almost as good travelers as the migratory birds, and have equally interesting life histories.

The Columbia river salmon, the king of fish, has its spawning waters far up the river at the spot in some mountain stream where it once hatched. If a dam is built that stops the salmon from swimming up the river, it will not lay its eggs. Many rivers have been thoughtlessly blocked to salmon.

After the eggs are laid they are fertilized by the male and left to hatch. When the young hatch out, they try to find their way down the river to the ocean. Unless precautions are taken, a great many are drawn into irrigation ditches or mill races and are lost. When the young salmon reach the ocean, they scatter far and wide, roaming the sea for three or four years. During that time, very few are caught. When the proper time comes, they return up the same river to where they were born. There they lay their eggs, and, like countless generations before them, float back down the river and die.

Since the laws of nature have decreed that salmon are to enter the same river at a set time, men have learned to catch them in huge numbers with nets strung across the river. The catch taken and canned on the Pacific Coast in 1936 was valued at over 35 million dollars. Up to the present, the process has been a wasteful one, and little use has been made of by-products which might possibly amount to more than the products themselves. Conservationists have lately learned that the waste contains valuable oil rich in vitamins A and D.

New dams have been taking into account the strange migrations of salmon, and are equipped with fishways or "fish ladders" to help them ascend the stream. Some are working successfully; others are not.

The lowly eel, that early fishermen thought was born from the heat of the sun on mud, also has an interesting life history; but, unlike the salmon, leaves the rivers at a definite time of the year and takes to the open sea to spawn. Somewhere in the middle of the Atlantic, the eels from America meet and reproduce with the eels from Europe. Most remarkable of all, each eel then returns to his own river home, the American eels to America, and the European eels to Europe.

After men have carefully studied a type of bird or animal, they are ready to try to make it feel at home. Perhaps all that is lacking is a shortage of spring food. Planting a few Japanese

Give us homes! Upper left, chipmunk; below, young moose; center, squirrel; upper right, brown thrasher; lower left, nesting pheasant; lower right, young robin.

barberry or high bush cranberry that hold their fruit all winter may solve the problem. Perhaps it is only that gravel is lacking. A load dumped in a convenient place may change the area from a desert to a paradise in the eyes of a bird.

Often a slight change in methods of agriculture may have a profound effect on bird and animal life. Most farmers take pains to clear fence corners and crop every foot of ground. They have not yet come to realize that a well regulated farm should provide

for wildlife. That little strip of brush along the fence may be exactly the protection that quail need to nest in or to find a retreat from their enemies. The quail might easily be worth more to the farmer than the use of a small strip of land. Fish and game departments have changed from police agents into game managers to help farmers to raise game just as they raise crops of wheat and cotton and corn. For wildlife is a crop, and it must be managed like one. Enough game must be left each year to seed the forests and streams and insure a harvest for the next fall. Wildlife is a crop that pays good dividends in pleasure, and sometimes in cash. In Iowa, game is a regular crop on many farms.

Game Management

As game managers, state departments have been working along other lines, and they have restricted unwise fishing and shooting. For example, in Pennsylvania notably, deer shooting is limited to one buck. The result has been to increase greatly the deer population, justifying a larger deer harvest. Fishing seasons should allow fish time to spawn.

The state has wisely limited the number of fish and animals to be caught so that the ignorant hunter and fisherman will know when to stop. A true sportsman is satisfied usually long before he reaches the limit. He has outgrown the idea that he must return with great numbers of game to be successful. He knows that he can fill his day just as well with six fish as with sixty. The real sportsman boasts not of the number he catches, but of the pleasure he gets from his fishing and hunting. He knows that one wild turkey in the bush is worth more to the world than ten in a bag. He carries out the spirit instead of the letter of the law.

Definite hunting seasons allow wildlife to rest, to mature its young without worry, and to face the sportsman with a better chance of surviving. Spring shooting of ducks once greatly reduced the number of good nests, and nearly destroyed waterfowl. Federal laws as well as state laws now protect the birds on their migrations and aim to prevent them from being harassed throughout the year. License fees collected are enough to finance 85 per cent of such work of state and Federal Government.

Besides setting limits, the state protects certain species that face extinction. The beautiful wood duck and several other ducks,

Wildlife must be given a chance to rest. Game laws wisely regulate the shooting seasons.

the whistling and trumpeter swans, the whooping and sandhill cranes, the ptarmigan and the woodcock need special protection in order that they may not go the way of the passenger pigeon. Antelope are now likely to survive though at one time their plight seemed hopeless. The wolverine, little tiger of the north woods, needs aid in his battle to live. The beaver especially needs better protection.

Vastly important has been the work of the Government and the states in creating game refuges. Areas have been set aside in which no hunting is permitted. Improved cover, small openings in large timber tracts, mixed instead of pure plantings of trees, a heavier cut in thinning a forest, and the encouragement of growths of hardwood greatly benefit conditions for the development of most animals and birds. Most refuges now are made small. They are just large enough to provide a sanctuary. Since some kinds of game have narrow cruising ranges and tend to remain within the refuge, the location of the refuges for these

species is changed after a few years. New centers of game population are thus built up.

Yellowstone Park furnishes a real center for elk and other big game preservation in the Rockies. Waterfowl have come to know that Jack Miner, at Kingsville, Ontario, is a friend, and thousands stop on his small reserve to rest from their migration flight. On the Federal game refuge in Louisiana, ducks and geese collect in almost unbelievable numbers. Itasca State Park in Minnesota, a refuge for more than 45 years, has permitted the deer population to increase tremendously. Though only seven miles square, its influence is great. On the opening morning of hunting season, wardens watch streams of deer coming from miles around to find protection.

Even though there are twenty million acres of game preserves in the United States, there is still a great need for more. At least twenty million acres more of the public domain ought to be made into sanctuaries for wildlife, especially for the big game that can not compete with civilization. There are seventeen million acres of marsh, water, and surrounding grassland that ought to be converted into refuges to allow migratory ducks, geese, and swans safe resting and nesting sites. Much of the eighty four million acres of swampland that was drained, ought to be restored and made suitable for wildlife. The Beltrami Island area north of Red Lake, Minnesota, with its 300,000 acres of marsh controlled by dams in the ditches, is an outstanding example of what might be done for wildfowl and fur-bearing animals in many other similar areas where drainage for agriculture was a failure.

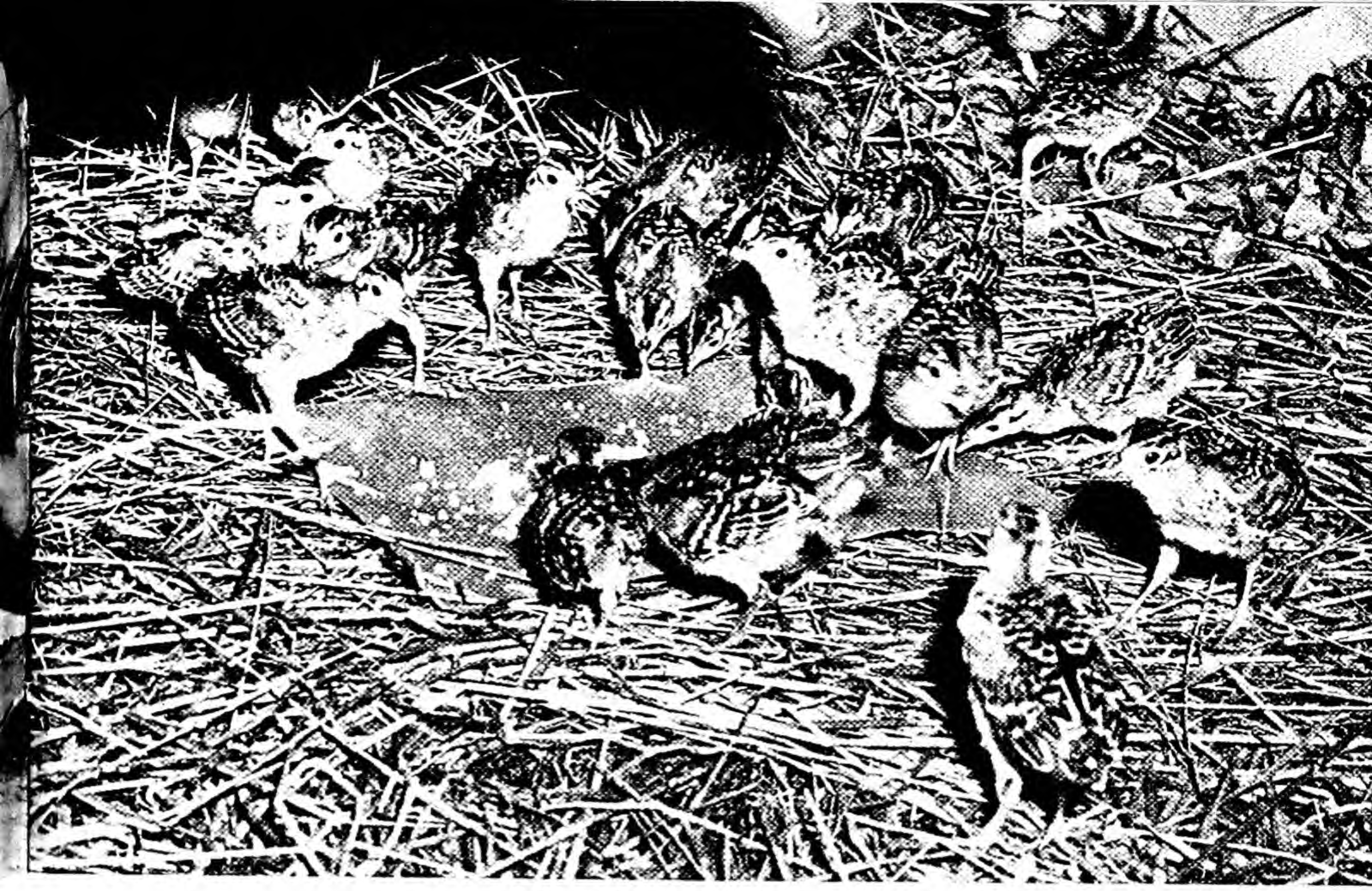
Increased attention to restocking refuges and other areas finally led to the thought that wildlife must not only be preserved, but it must also be propagated or raised. It not only helps to balance nature but furnishes pleasure and profit.

Game birds offered the easiest start, since they could be trapped and raised in captivity. Their eggs are easily hatched by the birds themselves or in incubators. The young birds are then used to stock areas where the birds are scarce or absent entirely. When it was learned that released chicks could prosper only where their home surroundings were suitable, men started to have success with restocking. Today many game farms are in

Game birds are being propagated for restocking sections which have run low. Pheasant eggs are hatched in an incubator. Tiny birds are removed from the trays for a four-week stay in a brooder house before being brought outside.

operation at various places, supplying principally pheasants, quail, Hungarian partridges, chukar partridges, and wild turkeys. Anyone who visits a game bird farm at the proper season can see hundreds of fuzzy chicks come out of the incubators. Young as they are the little birds stop cheeping and squat in fear when a shadow like that of a hawk falls across the floor.

Fish can be propagated even more effectively. Fortunately, fish lay tremendous numbers of eggs. A single lake trout, crappie, or pike lays thousands of eggs every year. In lakes and streams there are so many egg-eaters that very few of the thousands grow into mature fish. But, when female fish are "stripped" of their eggs and the eggs fertilized, a very large portion can be hatched and raised artificially. Many fish hatcheries have been established to raise young fish, or "fry." Over six billion were distributed by Federal and state hatcheries, in 1938. Among the fish most commonly raised for sportsmen are: rainbow, brook, Loch Leven, and black-spotted trouts, wall-eyed pike, large-mouth and small-mouth bass, sunfish, and crappies.



Breakfast time for these two-week-old pheasants means a feeding of chopped eggs.

When fry have reached a suitable age, usually only a few days, they are placed in large cans and distributed by cars or truck to the waters to be restocked. They are often carried over pack trails to remote lakes and mountain streams. Certain species are sent out as fingerlings.

Usually restocking game fish has been very effective when the proper stream or lake conditions have been selected. Sand will be suitable for one species; rocks or mud for another. The temperature must be correct and there must be proper food. Tiny fry that is dumped from docks into deep water has little chance to survive. Small fish must be freed where they can learn where to dart for cover. Even when conditions are correct for their growth, there are often no places for the young fish to spawn or build their nests. After this one group matures it dies out.

At times overstocking will result in a small size of fish. A farmer knows that when his pasture becomes overcrowded, his animals will be undernourished. Just so, lake bottoms must not be overpastured. Every lake has a limit to the number of pounds of fish it can support.

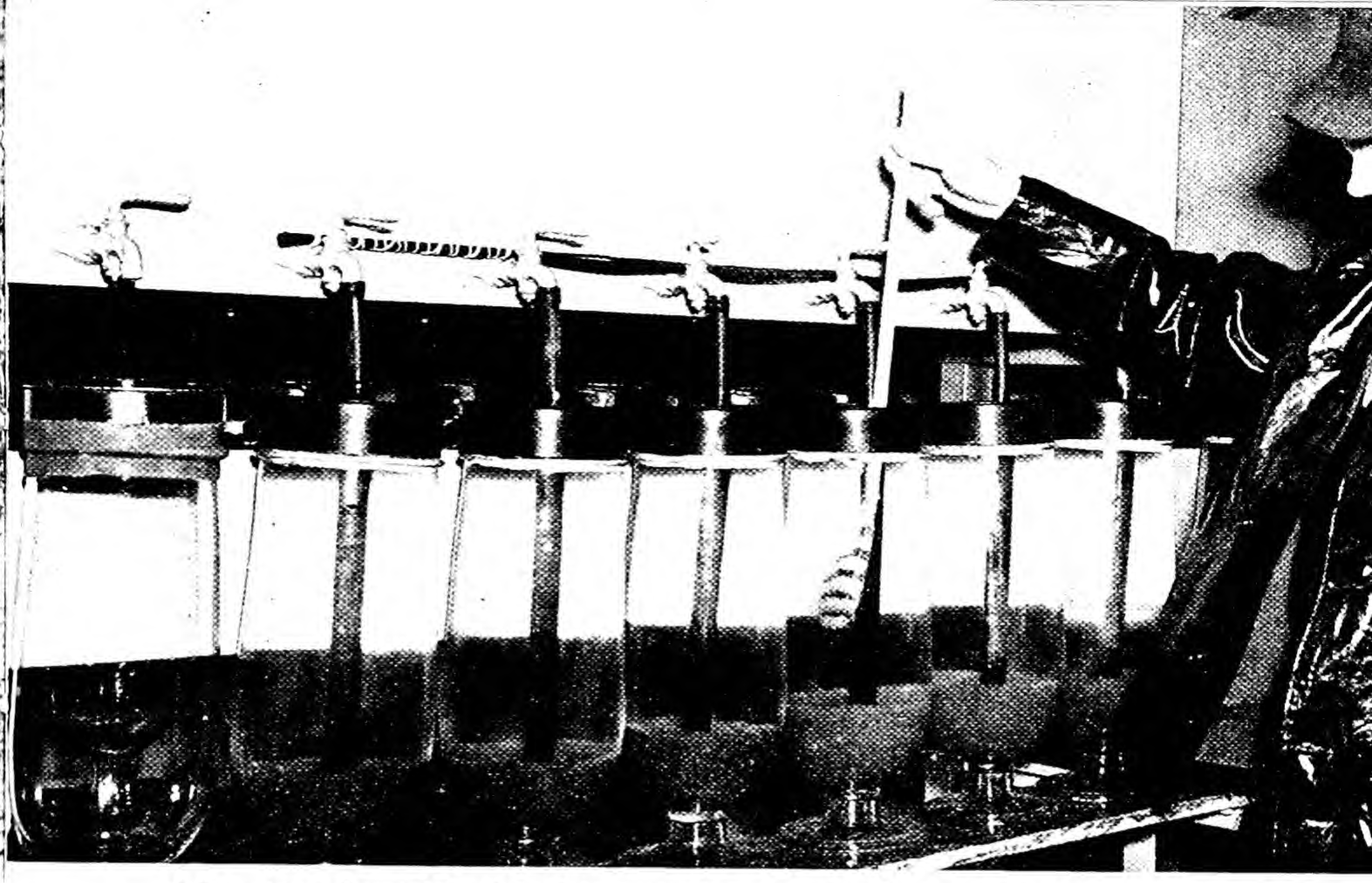
Fish propagation is a widespread conservation practice in Minnesota. Here a muskellunge is being caught to be stripped of its spawn. This fish has furnished eggs for several years.

Everyone Can Help

Conservation of wildlife, however, does not rest alone with laws, with refuges, or with good game wardens, but with every man and woman, boy and girl who finds pleasure in the wild creatures of woods and streams. Wildlife needs man's aid, not because it is helpless and weak, but because man has taken almost the last wooded acres, and turned under the wild fruit trees, nut trees, vines, and berry bushes. There are a great many ways in which every person can lend a hand.

One could hardly do better than Kubla Khan of old, who, Marco Polo said, not only forbade that game be killed during the months from March to October, but even went so far as to order that millet be planted along roadsides and in waste places to encourage quail and partridge.

Buckwheat planted in brushy country and along roads and fire lanes is very attractive to birds. Sunflowers, sorghum and cane, soybeans, cowpeas, peanuts, and popcorn left in the field are good. Shrubs like the mountain ash, snowberry, cranberry bush,



After they have hardened in running water, the eggs are placed in hatching jars where they are stirred from time to time with a feather to remove adhering air bubbles.

Stocking lakes with fingerlings is more often successful than distributing the fry. Here are lake trout fingerlings.

Marshes and swamps need not be idle. A small dam can be made to regulate the height of water. This Minnesota marsh is doing the job for which it is ideally fitted.

privet, bearberry, sour gum, Virginia creeper, holly, sumac, juniper, greenbrier and chokecherry, that hold their fruit well into the winter, should be planted where they are suitable. Sago pondweed planted in lakes and marshes will help wildfowl in its struggle. Wild rice, wild celery, wapata, and chufa are also good.

Wildlife needs man's help in the winter. A few sheaves of wheat, rye, and barley are fine for songbirds, but more is necessary to supply game birds. A few corn shocks left standing and torn open from time to time to expose the ears will carry over a large bird population. When weed seeds get covered deep, grain, chaff, or screenings placed in a sheltered position where it will not be quickly snowed under will be a help to many birds. When snow and ice cover the ground, it takes a steady supply of food to keep wildlife from starvation. Well-fed birds seldom die from cold, even in the severest winters. If food is near to cover, the danger from cats, hawks, and owls is small. Gravel should be exposed so that birds can find grinding stones.

Cottontail rabbits should be furnished with heaps of green brush or limbs when food runs low. Trees that are overmature may be cut. Good hay, chaff, and grain are especially good. Squirrels can ordinarily find all the food they need; but, at rare times, nuts and peanuts, or sunflower seeds may be fed. Planting

oaks and nut trees is the best encouragement that can be given squirrels.

Besides providing food, every conservationist ought to watch whether there is need for special cover to protect any species. Some brush or tall grass along the roadside or the edges of the field can provide nesting ground, a shelter when enemies pursue, and a shield against bad weather. Pastures that are not too heavily grazed will still leave homes for wildlife. A "flushing bar" can be attached to mowers to warn nesting birds of the coming danger.

Spring grass and brush fires are particularly destructive. Every man, woman, and child ought to be made aware that fires can wipe out every trace of wildlife in a few hours. A few good conservationists working together can possibly establish a refuge, if there is a need for one.

Sometimes the predators, or animals that feed on game, are killed off to insure that desired species will multiply. It would require the wisdom of a Solomon to say just when this practice may be wise or unwise. Sportsmen often declare war on the wolf, the coyote, the fox, the mountain lion, or hawks and owls, because they decide that a particular creature is doing damage.

Protecting wildlife is the job of every boy and girl who takes pleasure in the out-of-doors. This Wisconsin feeding station took only a short time to build, but it is giving help when aid is most important.

Predators are often the wardens of the wilds, keeping check on the species which might otherwise overrun the fields and forests. When all foxes are killed, rabbits may multiply to such numbers that they become destructive. The bay lynx or bobcat is a skillful hunter and, when not overnumerous, helps to keep wildlife in harmony. Owls and hawks keep fields free from rodents. The least weasel is a ferocious mouse hunter and prized for his fine white fur.

Most of the time a worse evil is loosed. Thus when all foxes are killed, rabbits often multiply so rapidly that they consume all vegetation and either starve or become subject to disease. A few years ago Government hunters killed most of the wolves and mountain lions on the Kaibab plateau. Before long, the deer population became so dense that the animals either starved or began destroying farmers' crops. Nature undisturbed exercises a mysterious plan that keeps each species alive. When man interferes, troubles quickly arise.

One predator, however, should be destroyed on sight—the homeless cat that must fight for his own living. Abandoned and left to himself, he becomes one of the most skillful and dreaded hunters in the animal world, destroying countless birds in a single summer. One ought to persuade his neighbors to destroy any unwanted cats humanely, and never abandon them.

The canny crow, too, deserves no protection. Apparently there is no danger of exterminating this vandal. Crows are wholesale destroyers of ducks' nests, small birds' nests, eggs, and young.

Hawks and owls are first-rate mousers, and keep fields and meadows from being overrun with rodents. A very few have been accused of attacking chickens, but this accusation certainly does not warrant shooting them all. A good sportsman will learn that hawks and owls are important in preserving a wise harmony in nature, and should be protected. In Germany, owls are considered valuable enough to be raised on a special owl farm and released where they are no longer found.

Federal and State Aid

The Federal Government has provided agencies to help the conservationist in his work and to supervise the wise use of wildlife resources. The U. S. Biological Survey makes studies of life habits, diseases, and value of game and fur animals, regulates interstate trade in wildlife, helps pass migratory bird laws, and distributes the information that it has collected. The Forest Service is working to improve conditions for wildlife in the national forests.

In the Department of Commerce, the Bureau of Fisheries studies the life histories of the more important fish, and supervises their propagation and annual catch. The Bureau of Lighthouses protects the breeding islands of certain birds, sea lions, and seals.

In the Department of the Interior, the National Park Service is in charge of wildlife in the national parks.

Just as important as the work of the Federal Government are the state game and fish departments. Administration of hunting, fishing, and trapping laws, and collection of information is part of their work. The biology departments of colleges and universities are doing valuable research work on problems of fish and game culture.

The Future of Wildlife

Although there are dark spots in the past, the future of wildlife today is bright. Where wise conservation has been applied

for a few years, results are already apparent. Our songbirds have been increasing under protection. Buffalo and elk are thriving under careful management. The prong-horned antelope is increasing in the refuges established for that much persecuted species.

Conservation on a large scale has been performing wonders. The fur seals on the Pribilof Islands are a good example. The United States bought the islands along with Alaska, knowing that about eighty per cent of all the fur seals in the world came there each summer to give birth to their young, mate and set out in the fall for an annual migration covering thousands of miles. At one time fur seals there numbered in the millions; but, with skins selling at high prices, they were hunted with so little thought of conservation that by 1911 less than 200,000 remained. Males, females, and young were killed at sea whenever they could be found, and fur seals were in real danger of becoming extinct. Thousands of seal pups starved to death each year on the Pribilofs when their mothers were killed at sea.

When the Government took charge, it was found that, by limiting the kill to three-year-old males, the herd would grow almost as fast is if none had been taken. Young males furnish much the choicest fur and they can easily be killed on shore where they gather by themselves away from the remainder of the herd. In the last 25 years, no fur seals have been killed at sea. Today the Pribilof fur seal herd numbers more than 1,800,000 animals and is increasing at the rate of eight per cent annually. Each year more than 50,000 skins are taken. The outstanding success with the fur seal is an answer to pessimists and a challenge to every conservationist to take action along still other lines.

A number of fine private associations have been formed for giving aid to wildlife.

The Izaak Walton League, formed in 1922 in honor of the author of the "Compleat Angler," is nation-wide, and devotes its efforts to protecting wildlife. The National Association of Audubon Societies, the Wildlife Society, the National Wildlife Federation, the American Wildlife Institute, the American Game Association, More Game Birds in America, Inc., and Ducks Unlimited, are great forces in protecting and developing a proper appreciation of wildlife.

With pure water, rich soil to grow protecting trees and grass, and a sporting chance, wildlife will stand firm in its struggle for life.

The states also have done splendid work in protecting and propagating wildlife. Refuges for birds and animals have been maintained; hatcheries have restocked lakes with millions of fry; and have enacted stringent laws governing times, quantity, and size of game that may be taken. Licenses are also required, and game wardens are employed for enforcement purposes.

Commercial Fisheries

An industry that adds almost a billion dollars a year to the United States and gives employment to very many men deserves special mention. Commercial fisheries furnish a special problem in conservation.

Ever since man first fashioned a hook out of bone and a line from the inner bark and roots of trees, he has been busy fishing. During early bible times, men "cast their nets into the sea"; down the years men fought wars over fishing grounds, and discovered new lands in search of them. Fishing, besides being one of the oldest pastimes, has been one of the oldest occupations. Today almost 150,000 men are employed in commercial fishing in the United States, not counting the thousands at work in canneries. The fish products canned during a year in Alaska and the United States approach close to a billion pounds.

The great wonder is that there are still millions of tons of fish and other animal food left in fresh and salt waters. But there are, and hundreds of kinds of fish, too. Each is good for something, whether for food or oil. A few are of superlative value, and great industries supporting large cities have been built around them.

There is plenty of evidence to show that something is wrong with the fishing industry—that too many fish are being caught, that they are caught at the wrong time, or in the wrong way. Especially many of the most popular species can not withstand the attack. A few figures should give proof.

Shad, the beloved fish of easterners, was once among the most plentiful on the Atlantic Coast. The annual catch amounted to almost fifty million pounds. Shad roe was considered a delicacy. With no regulation of the industry, shad were fished so vigorously that the catch dropped in a few years to 20 per cent of its maximum.

The catch of haddock at one time exceeded a quarter of a billion pounds. Now it is less than 75 per cent of that figure. Halibut is also rapidly disappearing. The catch of crabs in Chesapeake Bay, once as high as fifty million pounds, has dropped off 50 per cent.

Not content with moderate profits, commercial fishermen netted sturgeon until they are practically extinct commercially. Strangely enough, at one time sturgeons were regarded as unfit to eat, and, when they were found entangled in fishermen's nets, were killed and thrown overboard. When someone discovered the value of the roe for caviar and the fine flavor of smoked sturgeon, the unending war upon them began. With complete protection, it is hoped the sturgeon will return.

The ocean is in reality much like the Sahara desert. There are oases beneath the surface that feed immense numbers of fish, but for long stretches the population is sparse. Limitless as it seems, and covering more than three fifths of the earth's surface, the ocean can not support a drain upon it indefinitely unless a real study is made of the conditions that provide for the crop.

What must be done to preserve our great fishing industry? First, more careful study must be made of the habits of fish. The difficult part is, as has been shown, that the habits of one fish differ widely from those of another. What conservation measures may apply to one will be of no value to another species.

All along the East coast the shellfish industry—collecting oysters, shrimp, lobsters, crabs, and scallops—is important.

Much real progress has been made in conserving some species. The oyster is a good case. Oyster gatherers showed real fear when, after years of heavy takes, the supply began to dwindle steadily. Studies were made of the oyster's life history that revealed what was wrong.

Oysters produce millions of eggs that are such a delicacy to hungry sea creatures that few escape being eaten. The young oyster after hatching drifts about in the water until it finally grows heavy enough to sink. Then it gives up its voyaging for all time and if it should come to rest on some clean, hard surface, anchors itself, and continues to grow, layer by layer. Men who gather oysters grasp them with long-handled tongs, break the shells loose from the bottom, and load them into boats.

From unpolluted waters come fish like these.

When many beds stopped producing, it was discovered that there was nothing left to which the young oyster could attach itself. Empty shells dumped into the grounds furnished ideal anchorage, and the beds became productive. Other failing beds were found to be contaminated with sewage and silt that formed a coating over the entire bottom. Grounds that are established out of range of sewage and silt are an immediate remedy, and also prevent oysters from picking up typhoid germs and relaying them on to humans. Oysters have been found to be ideal carriers of the disease.

Today many oyster beds are as intensively cultivated as truck gardens. Grounds are rotated regularly, shells put in for anchorage, and the size of oyster taken is controlled. There seems no reason why the oyster should shrink under such management. More beds, however, need to be carefully managed and brought under control.

It used to be thought that oysters were fit for food only in months that contained the letter "r." That idea is not true, but would be a very good rule to follow. During the summer months oysters are full of spawn, and, although they are not dangerous for food, it would be poor conservation to eat them at that time.

The whale, although a mammal, is another product of the sea, and, because of its roving habits, is more or less of an international resource. Its size and value have caused men to hunt it for centuries. Lately, however, ocean steamers, swift gasoline launches, and harpoon guns have caused an alarming increase in the number killed yearly. A recent treaty made between several nations should protect the whale from the danger of extinction.

Obviously, since the life histories of fish vary so greatly, it is unsafe to apply the conservation methods which are effective in one case to any other without preliminary study.

A few statements are applicable to any fish conservation program, however, whether it be for commercial or recreational fishing. It is known, first of all, that most fish thrive in pure water. Yet, men have gone on heedlessly dumping out of mills and factories tons of poisonous acid and alkaline waste, poisoning the fish in the rivers for miles. Cities continue to dump their sewage into rivers and lakes by the millions of gallons; the decay of waste so draws upon the oxygen supply of water that fish

smother. Pollution of streams and lakes has probably spoiled more fishing than any other single factor.

Another statement applies alike to most freshwater fish; they must have free passage up and down streams. Spring or fall migrations are usually associated with spawning, and anything that interferes with their reproduction is fatal. A fish that is unmolested during its breeding period can stand a great deal of abuse for the rest of the year. A fish has remarkable powers of reproducing itself, liberating up to a million eggs; this power has enabled it to bear up under sustained fishing by man and heavy predation by other enemies. It must, however, be allowed free access to the particular spot where it is to release its eggs.

The third general truth that applies is that, if more fish are caught than are produced, the species will eventually die out. Restrictions on catch, especially in commercial fishing, will probably always be necessary to maintain a steady sustained yield. A regulation, for example, fixing the minimum size of lobster that can be put on the market would go a long way toward restoring the trade that has shrunk greatly all along the North Atlantic coast. Lobsters are slow growers; many that are now caught are immature and have not reproduced themselves.

Some fish may be imprisoned in river pools that gradually dry up, cutting off all roads of escape. Tile-drained marshes confine others to slow suffocation or starvation. The water level must be guarded if fish are to live. Silted river bottoms make the channel shallow and the water warm. If care is not taken, carp and other rough fish will replace the valuable ones.

What can be done, then, to stop the gradual shrinkage in this valuable resource? In summary, it becomes clear that, in almost every case, every man and woman can be of real aid in the following ways: (1) stop making sewers of rivers and streams; (2) see that all dams are equipped with fishways that a fish can use and screen the intakes of mill races, irrigation ditches, and other "blind alleys" that descending fish are likely to take; (3) regulate the catch so that the take will not exceed the increase; (4) prevent erosion on the watershed and preserve the water level so that streams and rivers may keep running clear and pure; (5) help the natural reproduction of fish by the collection and artificial hatching of eggs and the distribution of young fish or fry.

REVIEW QUESTIONS

1. In what ways did wildlife help to settle America?
2. How much of the slaughter of buffalo was necessary for the opening of the West?
3. Which animals and birds are facing extinction in the United States?
4. Which species of wildlife have gained and which lost under the increase of population?
5. What care must be taken in introducing exotics?
6. What are the reasons for the losses in wildlife?
7. Why do rabbits need protection during certain years?
8. Describe the value of song birds to country and city dwellers.
9. What creatures do you think are our best conservationists?
10. Discuss the value of wildlife to recreation.
11. What was the first step taken to preserve wildlife?
12. What did King discover are the needs of partridges? Which needs might be the same for pheasants, turkeys, or quail?
13. Before birds are released to restock an area, what preparations and study must be made?
14. How would you discover the wildlife population of any tract?
15. Describe the methods you would use to increase wildlife in your community.
16. What are the purposes of game laws?
17. How do game refuges and preserves help restore wildlife to surrounding areas?
18. What procedure would you follow to secure a good supply of fish?
19. What aid can be given game birds and animals through the winter?
20. How can farmers protect the wildlife population?
21. List the predators that deserve protection, and those that do not.
22. Which organizations have been important in conservation of wildlife? What benefits could you get from joining one?
23. Why must the commercial fisheries be preserved? Which fish are particularly in need of aid?
24. Outline a program for protecting one of the species of fish mentioned in the chapter. Study the habits and needs from other books.

SUGGESTED ACTIVITIES

1. Attend meetings of local associations for promoting wildlife. Which of them might you find profitable by joining? Are there any to which junior units might be added?
2. Write for detailed laws regarding hunting and fishing in your state. Why is each regulation advisable? Write for game laws in other states and compare them with your own.
3. Make pets of wild birds and animals where they are. Watch them from day to day. Learn to approach them cautiously. What are their special needs for food, shelter, and propagation?

4. Make an inventory of the wildlife in your county. On your record show the place found, abundance, and need for protection. Ask old settlers regarding the wildlife present in former years. Where have there been gains and where losses?
5. Map your community, showing gullies, groves, fields. Show where there should be tree plantings, where cover, and where food added.
6. Listen to bird calls, and learn to identify them. Which notes are intended for alarm? Observe migrating birds. What are their chief dangers? Are there swamps, marshes, rivers or lakes which you might convert into refuges where they can rest unharmed?
7. Study bird, animal, plant, and insect life in a meadow. Show how each interdepends on the others. Make the same study for the swamp, forest, and field.
8. Give a brief account of the work of such men as Thoreau, Hornaday, Miner, Seton, Izaak Walton, Fabre, and Agassiz. If you accomplish some worthy project locally, such as establishing a refuge, perhaps you might name it in honor of one of these men.
9. Provide nesting places for small birds which shall be free from marauding cats. Make birdhouses suitable to several species. If you live on or near a farm, see whether you can persuade men to leave corn shocks or other suitable food in the field.
10. Build nature trails through near-by forests or fields, labeling plants, trees, and the homes of wildlife. Stimulate interest in the trails and get neighbors to use them.
11. Here are a few of the many programs which an active class can plan and carry out: discourage improper use of poison and traps; control stray cat and dog population; plant cover and food along roadsides; plant pond vegetation that is recommended by the local game and fish warden; plant yards to fruit trees which are attractive to birds; and build winter feeding stations.
12. Plan a visit to a fish hatchery, game farm, or fur farm. Invite the managers of one of them to speak to the class.

Debate: Resolved, That hunters should pay farmers for the right of hunting game on their property.

CHAPTER EIGHT

Minerals and Mineral Fuels

THERE IS MYSTERY in hidden minerals. They draw a man into unfrequented parts of the earth and make him willing to endure hardship and danger.

Men by the thousands were drawn over the western plains and deserts when rumors of gold trickled in from California in 1849. Men risked their lives and fortunes in a wild scramble to reach the gold fields of the Yukon. Savage tribes of Africa could not keep the British from the diamond mines of Kimberley.

Whenever rare minerals or oil are discovered, men are likely to become filled with the thought of sudden riches. They believe, if they are easily found or found in abundance, that they are inexhaustible. For this reason minerals and fuels have been badly wasted from the time they first were used.

The great wastes which result from the mad rush for riches can be illustrated by the development of an oil field. First comes the rumor one day that indications of oil have been found. By morning the next day, the region is crowded with men eager to buy leases for the mineral rights of adjoining land. Not one person stops to consider that there might be an oversupply of petroleum on the market at the time. Each thinks only of his immediate fortune and bends every effort toward drilling.

Oil occurs in saturated sand in large pools beneath the earth's surface, and when one well is drilled it draws oil from the general reservoir. The situation that develops may be likened to a dozen people each with a straw drawing pop from the same bottle. Anyone who might try to save his supply for a later time would find himself without a drop. So, to extract just as much oil as possible, wells are sunk everywhere. The more wells a man drills, the more of the pool he can get for himself.

Many of the drillers are poorly equipped. If the well should come in suddenly, there is often little preparation made to care for the flow. The oil runs over the ground and is wasted. Former-

The call of hidden minerals draws prospectors far back into the hills. A pack train of the U. S. Geological Survey on the trail to Moab, Utah.

ly the chances were great that it would catch fire and burn for days before it could be brought under control. Very often the gas is allowed to escape. As a result, the oil must be pumped out instead of being forced out by the gas which is the easiest way of producing oil. Very often, too, salt water comes and drowns out the oil.

In addition to the great wastes in production, whenever minerals are extracted with great speed the market is likely to be oversupplied and the prices greatly reduced. When prices drop too low, a mineral is likely to be used wastefully.

The opening of oil fields encourages the growth of boom towns that thrive and expand for a time. The tremendous drain of a great many wells soon leaves a field dry. Towns fail and the citizens are left without any means of support. Later the towns are deserted to become "ghost towns" amid dreary forests of abandoned derricks.

All this means a staggering economic and social waste. The uncontrolled scramble for immediate profits has squandered in a few years what might have supported a prosperous community for a lifetime or more if properly managed. What has happened with petroleum has happened in a greater or less degree to all our mineral resources. The pressure for profit prevents any vision beyond today. Little thought is given to the future or the good of the country in years to come.

The Mineral Resource

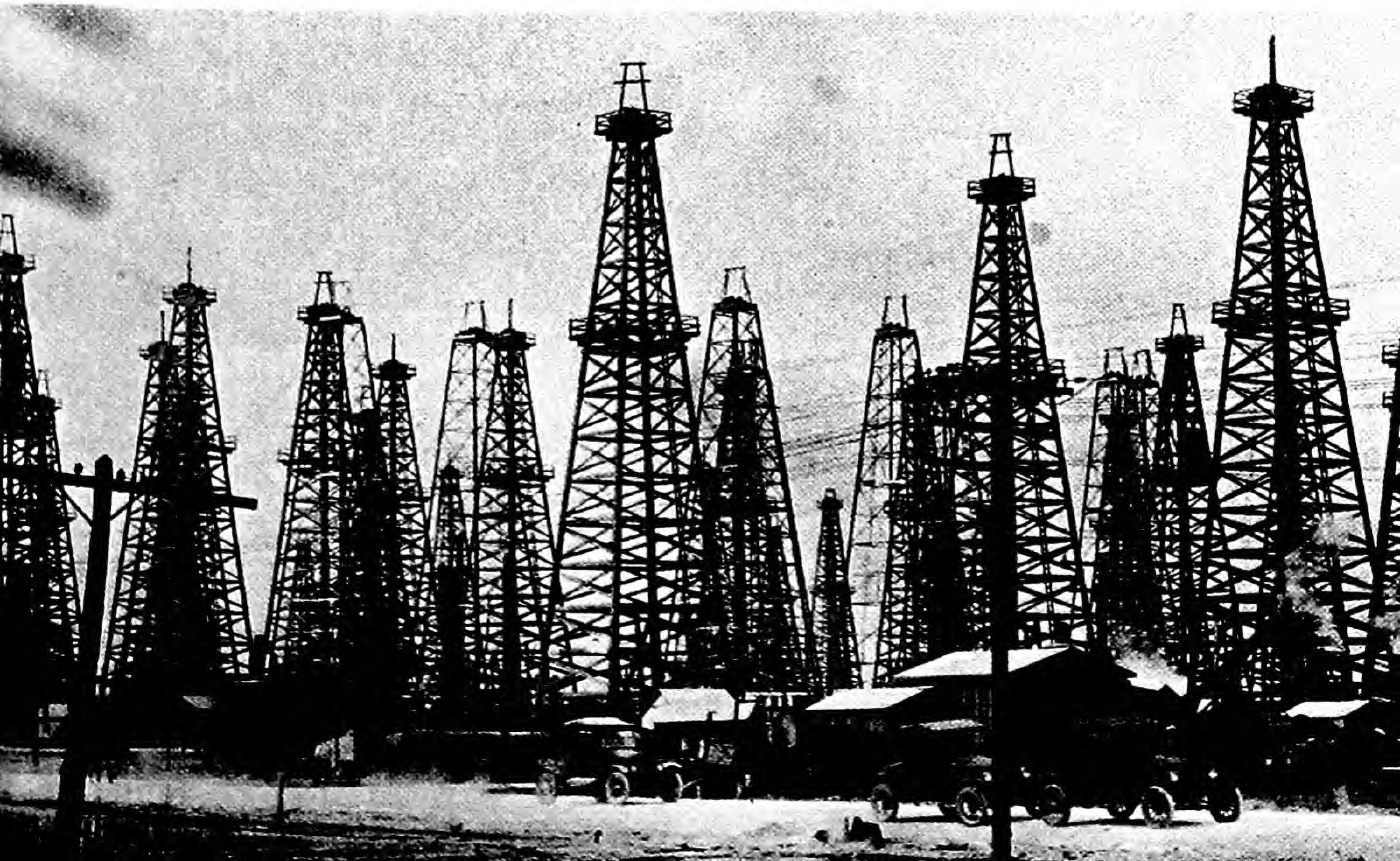
Mineral resources are unlike those other forms of wealth already described. The forests, grasslands, wildlife, and to some extent, soil and water, can be renewed with proper care. Minerals, on the other hand, are nonrenewable. Nature does very slowly restore minerals if the same conditions under which they have been formed are returned. But that process requires periods, according to geology, of several thousand years. As far as man is concerned, minerals are nonrenewable. In the earth's crust there is only a definite, set amount of each mineral treasure. When that is gone, there is absolutely no more.

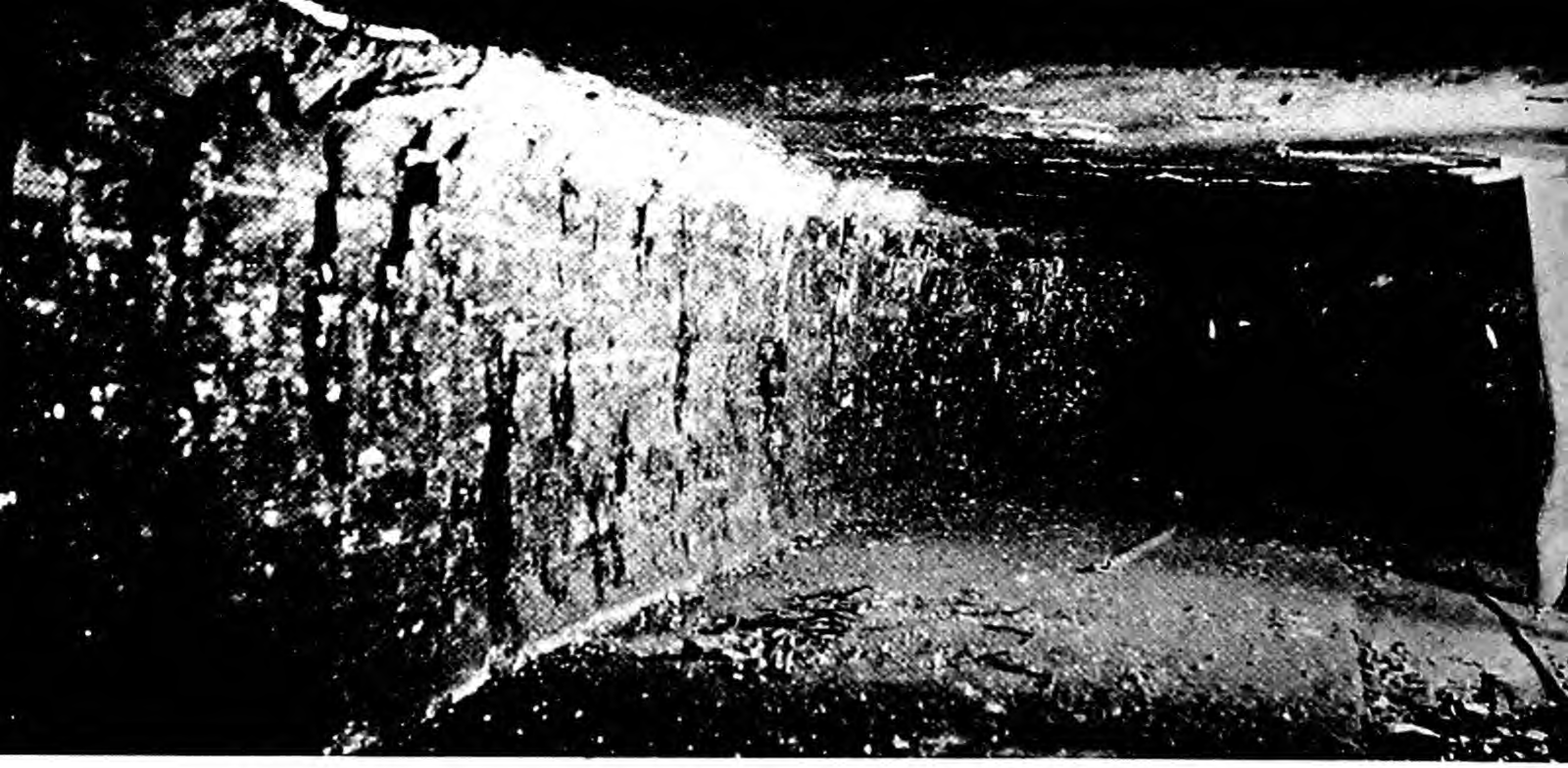
Some minerals are rare; others exist in enormous quantities. But every one can be exhausted entirely. It is stupid for anyone to use even the most plentiful except as wisely as we know.

When a mineral is said to be approaching exhaustion, ordinarily what is meant is that mines are going deeper and deeper or possibly that the ores used are getting leaner and leaner until eventually it is no longer profitable to extract them.

A mineral will perhaps never be completely exhausted as some of our wildlife has become extinct. Metals covered by miles of rock and earth will likely not be profitably mined unless great

The future is forgotten in the mad scramble for mineral wealth. A man who might conserve his supply of oil would find it drawn away by such a forest of derricks.





Minerals can not be renewed. Once mined from the ground, they are forever gone. The coal mine shown here is in West Virginia.

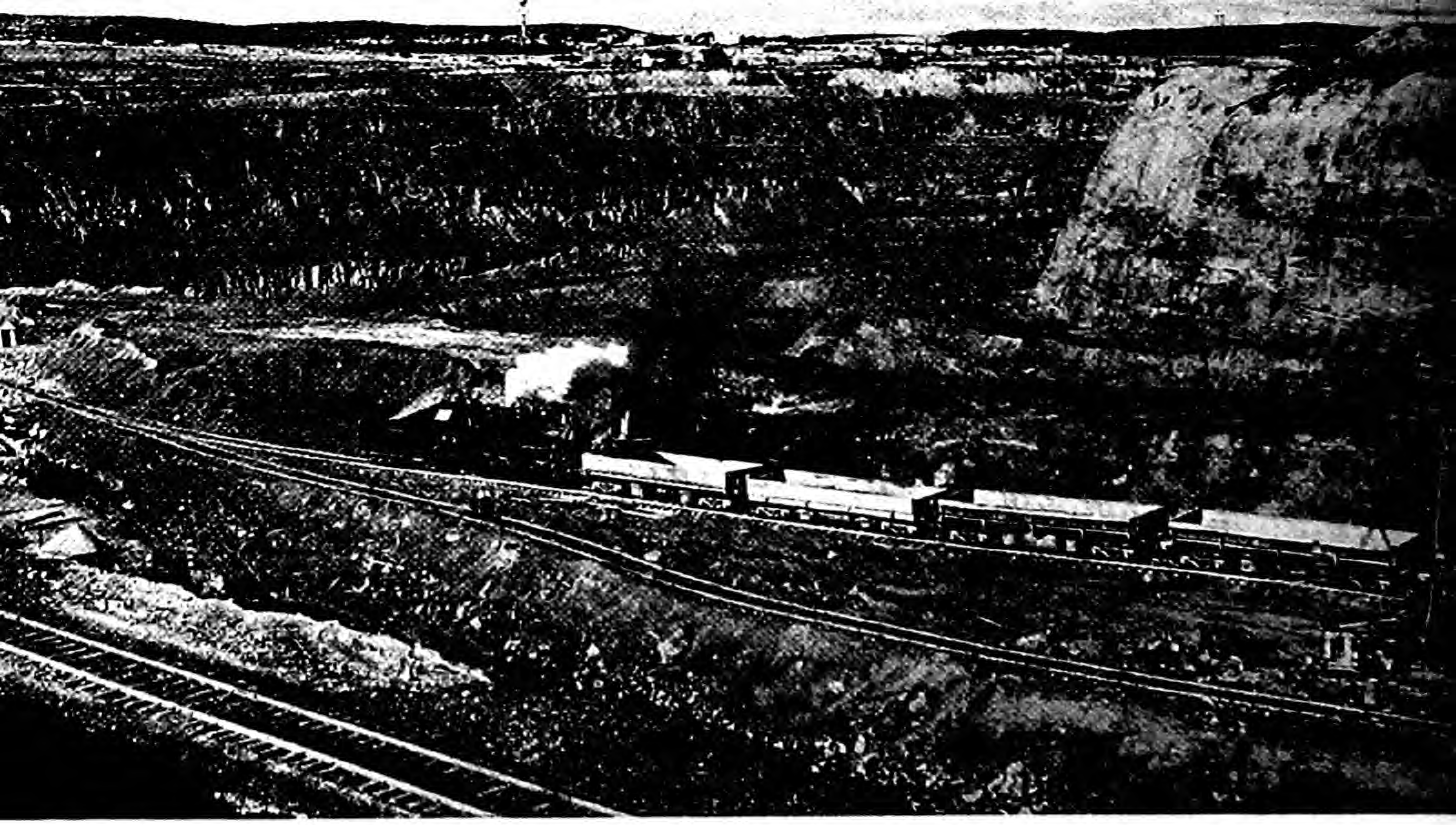
discoveries will permit much deeper extracting at small cost. Furthermore, large deposits of metals can not be utilized if they are scattered in too scanty mixtures throughout rocks. Already the pinch of approaching exhaustion is felt in some mining industries, even though only a small part of the supply has been used.

Iron is a good example. The United States is thought to have more than four billion tons of the ore. Comparatively little of it has been used, and yet iron mining is already quite different from what it has been.

When iron was first mined, the richest or the most easily available ore was used. Each man in a day's time could produce a large volume of iron. The longer that mining went on, the deeper the mines were opened as a general rule. The first few years skimmed off much of the rich ore. Later the poorer and deeper ore was used.

When ore was first taken from the Mesabi range in Minnesota, it was found almost at the surface. It was of such high grade that it could be hauled directly to the steel plants. Now that same grade of ore must be taken from a depth of 200 to 300 feet, and almost half of it has been mined. In another 25 to 30 years, at the present rate of use, the high grade ore will be gone. Mines will be forced to use lower grades that must be put through a concentrating process before being smelted.

As minerals become scarcer, men devise better ways of extracting them. Mines go deeper, and giant steam shovels strip off the cover of earth. This one takes 12 cubic yards at a single bite.



In 25 or 30 years, the high-grade iron ore of Minnesota will be gone. This open pit mine has produced 53,836,348 tons. Just how long it will support its families of workers depends on the way it is managed.

Whereas one man can produce a carload of the first-grade ore ready for smelting, it takes seven men to mine the same quantity of third-grade ore and prepare it for the smelter.

It is easy to see, then, that producing a ton of iron becomes more and more difficult as time goes on. Why is it that the price of iron has not risen at the same rate?

The answer is this. While mines have been going deeper and the ores used becoming leaner, men have been constantly at work devising better machines, better methods, and better economies. The result is that today a man produces more metal than was possible thirty years ago.

The same change is occurring in mining other metals. There is a constant contest between improved machines and methods on the one side and more difficult and more expensive mining on the other. Some day technology—that is the word for our better machines and methods—must certainly fall behind. When it does, the cost of everyday articles made from iron will rise in price.

The new flotation process for concentrating ores has revolutionized the extraction of many metals. It was found that, when

Coal mines have been going deeper, and reaching farther back into the rocks. Eventually they will certainly be exhausted or become so deep that mining is impossible. This mine in Harlan County, Kentucky, has gone one mile back into the rocks.

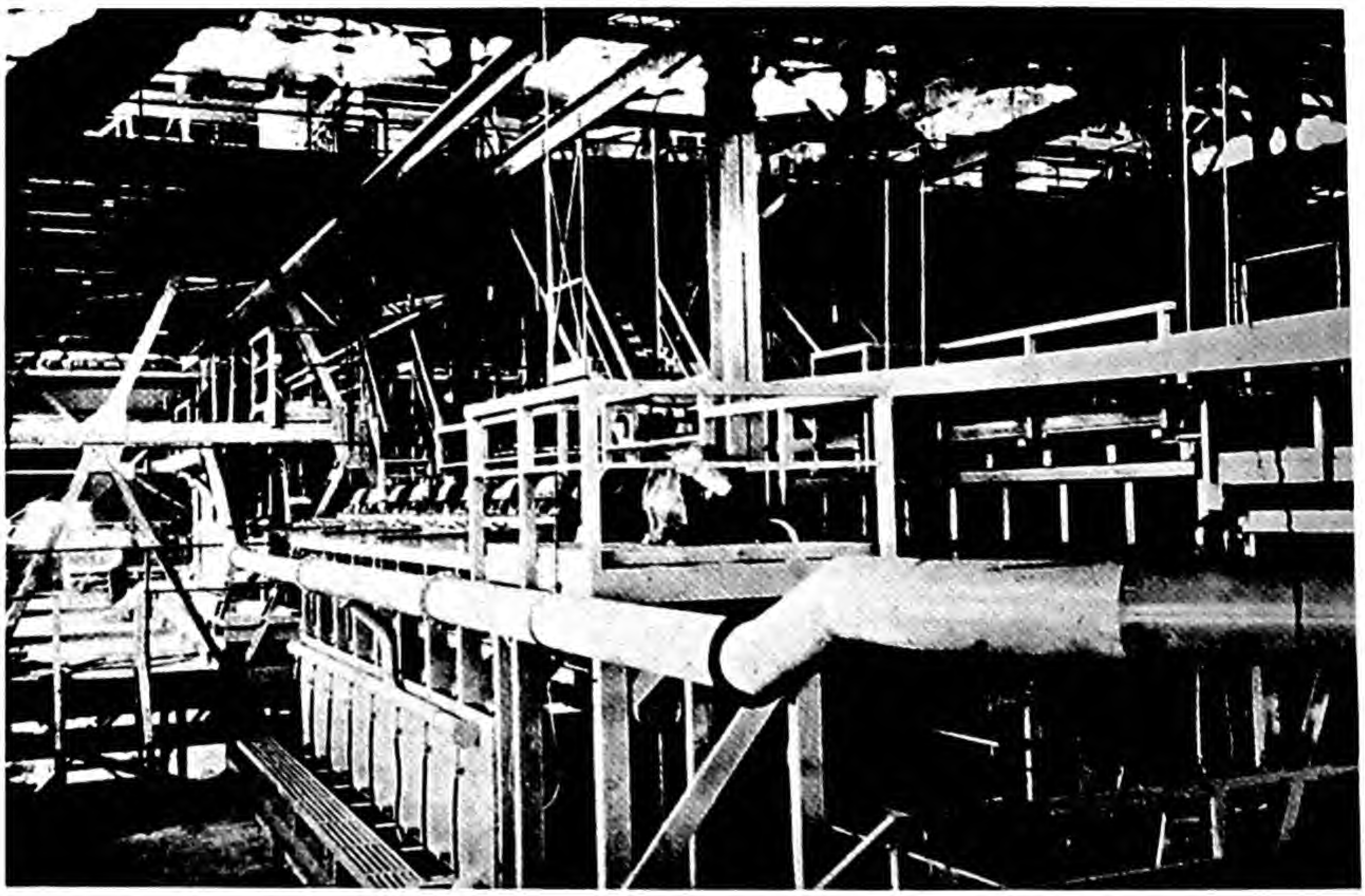
a liquid is made to froth up through the crushed ore, small particles of metallic minerals adhere to the bubbles and are separated from the nonmetallic waste. The discovery made possible the use of large bodies of low-grade ore which had formerly been regarded as of small value.

Whenever low-grade ores can be utilized, we increase very greatly the length of time that the supplies will last. In the case of iron, technical discoveries have meant an increase of several thousand years' supply. The better methods can be applied to mining, to concentrating, to refining, to manufacturing, or to re-use of the mineral.

The Management of Minerals

The wise use of mineral resources requires a program of several parts. In the first place, harmful competition in mining should not be allowed to waste our resources. When there is no plan or control, men rush to extract only what is easy to reach. All the rest is wasted. Some ore is covered so deep with the

dumps from surrounding mines that it is very expensive to recover. Under better smelting and refining processes, some of such deposits would be valuable. Harmful competition in coal mining has resulted in the loss of much top-grade material left for supports and in rich veins left because they were inconvenient to mine. Abandoned mines often fill with water, cave in or other-

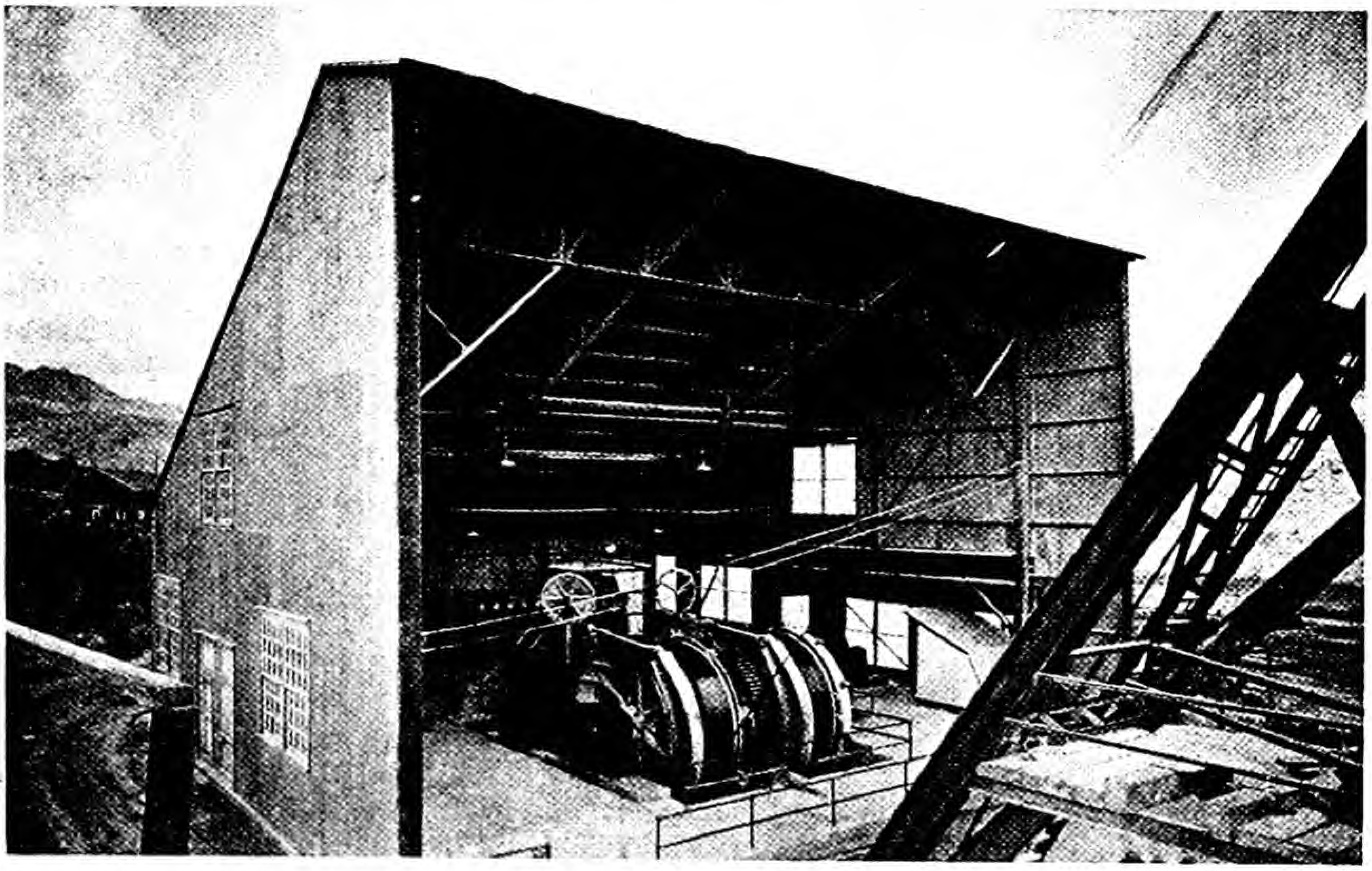


To postpone the day when minerals will be gone, men have discovered means of using poorer ores. In this copper plant at Midvale, Utah, the flotation process removes metal from ore once thought worthless.

wise make it difficult to recover any remaining ore. Since the Government established quotas to fill, great good has resulted. There must be some governing body to direct how minerals shall be managed to provide for the future.

In every conservation program there must be emphasis on knowledge of the resource. Knowing how veins of ore are formed has prevented the strippings or waste of one mine from being dumped on top of other beds. Study of oil deposits allows each dome to be tapped and drained more completely without the losses that used to occur.

In planning how to decrease waste, attention must be given to better methods of refining and smelting the ore. Thousands of tons of the low-grade iron ores went unused before the plan of mixing and enriching different grades was developed. Before the "cracking" process, petroleum was producing only about 15 per cent gasoline, much less than is now recovered. Great



Electrically powered hoists such as this one in use at Ray, Arizona, allow men to search ever deeper for copper.

progress has been made in conserving minerals by more efficient processing, and there will undoubtedly be much greater advances in the future.

By-products have been grossly neglected in the past. Already the by-products in some industries have proven to be more valuable than the original product. No raw material is yielding its best until every by-product is wisely used. American capital and ingenuity are constantly trying to prevent waste or to discover new uses.

Minerals must be put to their highest uses. This is an important part of conservation. If iron will take the place of copper

in kettles, the copper should be replaced with the more abundant metal. This will allow copper to be used for electrical instru-

Common minerals must take the place of rare and more valuable ones. Each should be put to its highest use. Aluminum, the most abundant metal, is being substituted for iron and copper for many purposes.

ments where iron will not serve. There are places where both iron and copper can be replaced with aluminum, of which there is a great supply. Chromium plating can very well take the place of silver plating in many cases. When a real shortage in any of the metals arises, there will be even greater substitution and the metal will be saved for its most valuable use.

Although minerals are not renewable, they are re-usable. This factor is important and will grow to have greater meaning in conservation. Most minerals except the fuels are durable and can be reworked again and again. Copper, especially, since it rusts but little, is well suited to re-use. Much scrap iron is gathered together and resmelted to find new usefulness.

There are still other ways of using minerals wisely, but enough have been mentioned to illustrate that their conservation, like the conservation of other resources, must be the duty of every man, woman, and child. Much broken or worn metal is constantly being thrown away or covered in dumps. These pieces, if saved by those who discard them, would add materially to the quantity salvaged.

In America, particularly, the use of minerals must be jealously watched. In the distribution of minerals, the United States is a lucky country. No other country in the world comes near us in abundance. Within our borders lies 40 per cent in value of all the minerals in the world. Another 10 per cent of the minerals in foreign countries is controlled by American interests.

Let us make a survey of the mineral resources. This knowledge is necessary to discover the best means of preserving them. The principal ones are listed here in commonly recognized groups. The mineral fuels are coal, petroleum, and natural gas. The major metals are iron, copper, lead, gold, silver, and zinc. The minor metals ordinarily include aluminum, antimony, cadmium, chromium, manganese, mercury, nickel, platinum, tin, titanium, tungsten, uranium, and vanadium.

The nonmetals include three divisions, building materials, fertilizers, and chemicals. The principal building materials are cement, lime, sand, gravel, and brick clay. The fertilizers are phosphate rock, lime, kaolin, potash, and nitrates. Chemicals of major importance are arsenic, sulphur, calcium, borates, and barite.

Within the United States lies 40 per cent in value of all the minerals in the world. In this picture, taken at Baton Rouge, Louisiana, a small fortune in oil is being transported by barge.

The Fuels

Coal

Coal is one of the first in importance. It was formed in far distant times when vegetation grew rank. Ferns grew to the size of trees. The accumulation of leaves, twigs, and other organic matter was great. Plants died and were covered with water before they decomposed. The result was the formation of an immensely thick layer of peat, much the same kind that is found in many swamps today.

Later, when the earth heaved, it folded the beds of organic matter and brought them under great pressure. There they lay unused for countless ages. Four hundred feet of vegetation were required to produce twenty feet of coal.

Some of the people in ancient times had a vague knowledge of coal. They knew only that in certain places fires burned within the earth for many months. People in Italy and the Balkans knew that the rock would burn, but used it only a little, since they had very little and their climate was warm. It remained for two northern countries, Germany and England, with a bent for industrial development to make commercial use of coal.

Coal was discovered in America quite early in history, but, with much wood within quick reach, there was little need for another fuel. The first coal mined in the United States came from Virginia in 1787. A little later small mines were opened in Pennsylvania, but the quantity taken out in the next quarter century would hardly fill a train of cars.

Coal was important in changing the industrial life of the nation. Large factories sprang up everywhere and work was taken out of the home. Coal was easier to transport to factories than the more bulky wood, and the use of coal increased rapidly.

The total amount of all classes of coal known to exist in the world reaches the staggering figure of more than seven trillion tons, a huge supply of stored energy. Of this quantity, over 68 per cent is in North America, 17 per cent in Asia, 10 per cent in Europe, 2 per cent in Oceania and less than ½ per cent in South America.

The United States possesses more coal than all other nations together. This fact is important, since coal is an indispensable mineral. It is said that when coal and iron are found in abundance near each other, the two are of much more importance than all other mineral products combined.

The United States is almost as favored in the distribution of its supply as in the quantity. Had all coal been concentrated in one region, the industries might need to have been clustered around that spot. Coal has been found in considerable quantities in over half the states in the Union.

Coal exists in several forms. From peat, which is a coal-like substance not very far removed from vegetable matter, it ranges to anthracite, which is jet black and as hard as stone. All classes grade into each other. The classifications have been arranged according to their heat-producing ability, and also on the carbon content. A number of kinds have been recognized commercially.

Peat is found over great areas in swamps, marshes, and meadows where it varies from a few inches to twenty five feet in depth. Although widely used as a fuel in Ireland and the Scandinavian countries, peat has not been important for fuel in North America. Before burning, peat must be dried. Attempts to mold and dry it into briquettes have been successful; but, with other fuels at low prices, the efforts have been largely discontinued.

Peat has one distinct value over the different kinds of coal. It is grown in a comparatively short time. Most of it is formed from sphagnum moss, which grows rapidly. Peat may, therefore, be looked upon as a renewable resource. Some day it may be of great value for fuel and energy, since there are almost unlimited acres of it. Peat is finding a very worth-while use as a soil conditioner in supplying lightness and the desired texture.

Halfway between peat and the soft coals is lignite. This very soft coal produces four or five times as much heat as peat, but less than half as much heat as hard coal. When exposed to the air it slakes, and may ignite spontaneously. For this reason it can not be stored or easily transported. Great deposits are present in the Dakotas, Montana, Wyoming, Colorado, and the states bordering the Gulf of Mexico. In some parts of North Dakota there is a lignite mine on every farm to supply fuel for heating and cooking.

Bituminous, commonly called soft, coal, is the most widely used. Its output represents slightly more than half of the total production of coal. It is preferred for making coke and illuminating gas, and for domestic use. The best coking coal comes from Pennsylvania and West Virginia, but bituminous coal is found throughout the Appalachian region from Pennsylvania and Ohio to Alabama; also in Michigan, Indiana, Illinois, Missouri, Kansas, and other states. Less valuable grades are found in several western states.

Anthracite, or hard, coal is the highest grade. Being very hard, it does not crumble like the soft coals. It is clean and burns with very little smoke. The distribution of anthracite, unfortunately, is greatly limited. It is found in large quantities only in northeastern Pennsylvania. Other deposits have been found in Colorado and New Mexico, but to date they have not been used. Almost a third of the known deposits in Pennsylvania are used after less than three quarters of a century of mining. In 1936 this state mined nearly fifty-five million tons.

The wide distribution of coal has speeded the nation's development. Cheap transportation was made possible. Railroads have been able to refill their tenders without any very long haul. If they had needed to carry all their coal across the country, freight rates would necessarily have been much higher.

So houses are warmed, factories run, trains sent steaming along their tracks—all by vegetation that died and was buried in the earth ages ago. That is the romance in a ton of coal! But there are other stories of the values and almost magic powers in coal.

Chemically, coal is one of the most amazing materials under the sun. From it can be distilled an almost unbelievable variety of products. The guide in a steel plant might point to a pile of gray material and tell you: "This is ammonium sulphate, a by-product of the coke ovens. It is shipped to Hawaii to be used as a fertilizer on pineapple plantations."

But there are even more startling things than fertilizer in coal. Camera films, exquisite perfumes, headache tablets, brilliant dyes, deadly explosives, creosote, naphtha, lysol, carbolic acid, oil and gas substitutes and a hundred other items.

Coal Conservation

The problem of conserving coal is a difficult one. Unlike the metals, mineral fuels can not be re-used. Use destroys them com-

Careful mining will allow all coal to be removed when two beds lie near each other.

pletely. A little sulphuric acid may be recovered out of the "coal brasses," but that is of no help to the fuel situation.

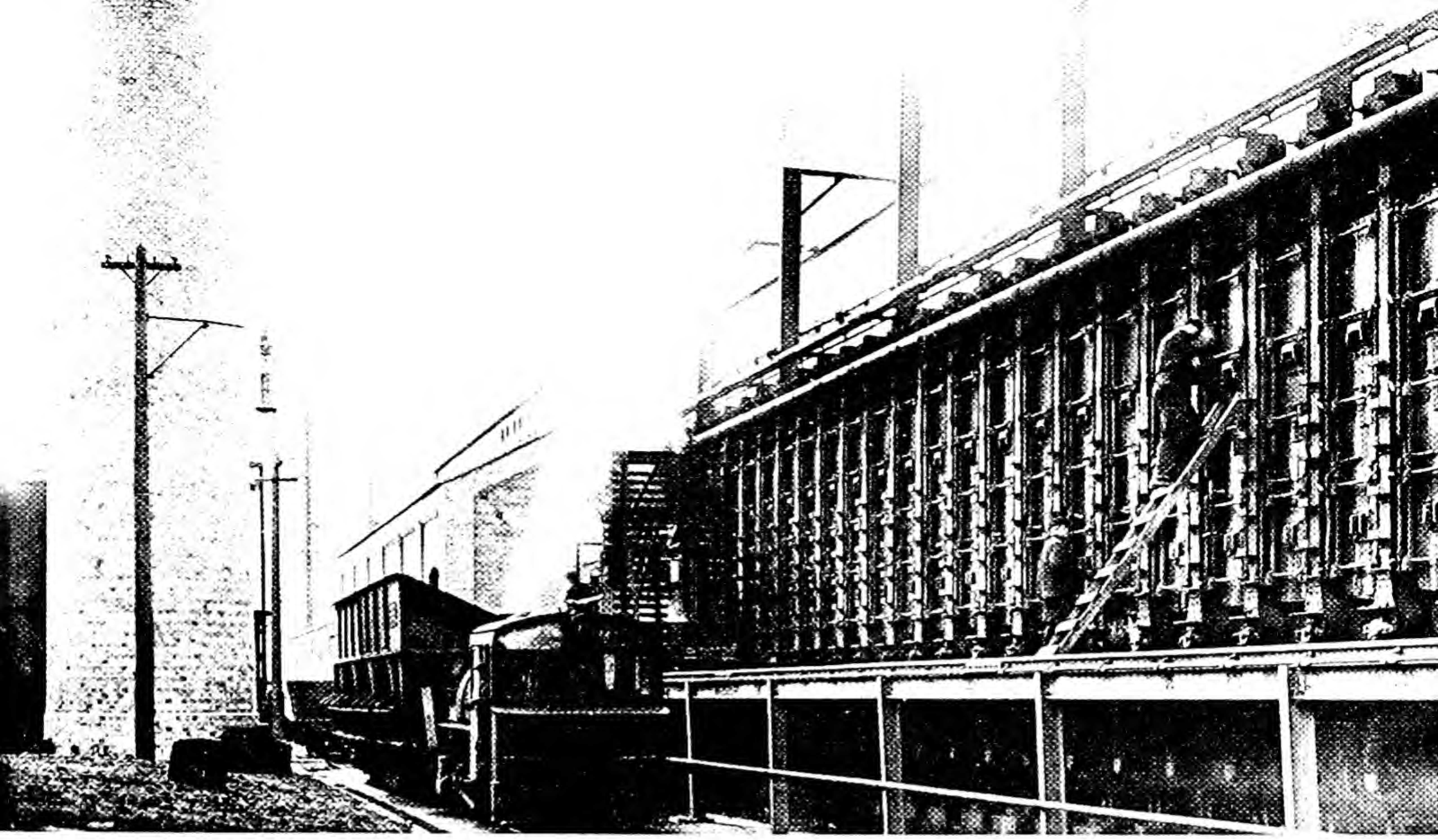
Coal can, however, be mined with less waste. It has been common practice to leave great columns of coal in the mines to support the roof during mining operations. These pillars are usually left when the mine is abandoned. Blasting and rough handling break up a large part of the soft coals into dust and small pieces. New methods of cutting up coal are already known and ought to be practiced. When two beds lie near together or one above another, it is common practice to mine only the better one. The poorer bed, often covered by debris or water, is difficult to mine.

Only through complete burning or combustion can coal be fully used. So far this complete combustion has not been fully accomplished. A large percentage of the value of coal goes up the smokestack. A steam engine makes use of only 15 to 25 per cent of the energy in coal.

Heating coal without the presence of air drives off certain valuable compounds. The resulting product is coke, which is used for fuel. By coking coal before it is used, such valuable by-products as tar, oil, illuminating gas, ammonia, and tar products are recovered. These often amount to more than half the value of the coke produced. Failure to convert coal into coke before it is used costs the nation about 250 million tons of coal yearly.

Still another saving in coal results whenever machinery makes better use of its energy. In 25 years, the quantity needed to produce a kilowatt of electricity has been reduced from 5.3 pounds to 1.5 pounds. Such a saving is equivalent in effect to finding a huge new deposit of coal. More effective combustion, also, has prevented much waste.

A very great saving can be made in the transportation of coal. Loading and unloading breaks it into lumps and often causes loss of grade. Being bulky, coal also is costly to handle. A process of converting it into a liquid fuel like oil is called hydrogenation, and may allow the energy from coal to be piped as a liquid from the mouth of the mine. To do so would make available great quantities of sub-bituminous coal in the West that can not now be satisfactorily used. Since oil is quite definite-



Failure to convert coal into coke costs the nation 250,000,000 tons of coal every year. From this modern coking plant many by-products are captured which often amount to more than half the value of the coke.

Although it is estimated that the stores of coal are sufficient to last a thousand years, the costs of mining deeper and deeper beds will greatly increase. In America a ton of coal is produced by 1.7 hours of work. In England it takes 7.5 hours.

ly more limited in quantity than coal, there will in time come an even greater need for hydrogenation.

It is estimated that the coal supply will last for about a thousand years. Perhaps complete exhaustion is that far away, but practical exhaustion may be nearer than is realized. Every year the cost of mining a ton is increased. In England where the mines are older, it takes 7.5 man hours on the average to produce a ton of coal. In the United States 1.7 hours are all that are needed. We must begin right now to use coal wisely.

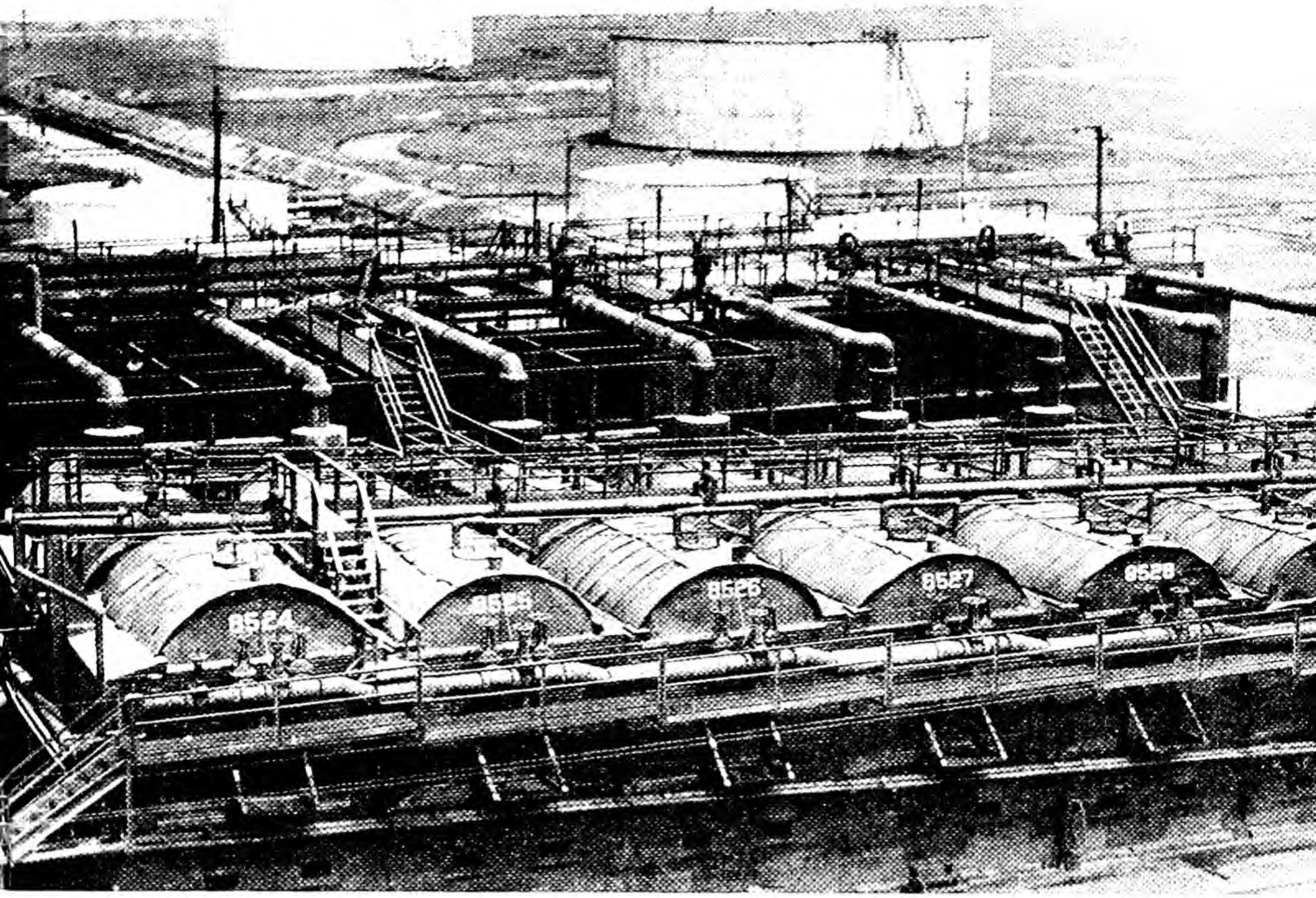
Petroleum

The next great mineral fuel is petroleum or oil, a substance of wide uses. It was discovered long ago in ancient Persia, where natives watched it ooze out of certain hillsides, a black, greasy substance which sometimes caught fire and blazed for weeks. Most Persians looked at it with awe and superstition, while a few of the more adventuresome used it as an ointment.

Petroleum is said to have been burned in lamps in the days of Herodotus, the old Greek historian who lived several hundred years before Christ. If it was, its use had become a forgotten art by the time America was settled. Petroleum seeps had been noticed in Pennsylvania at an early date, but no one looked on them with an eye to development until Colonel Drake performed what was then the nearly miraculous feat of boring a well sixty-nine feet deep near Titusville, Pennsylvania, in 1859.

At first, petroleum was sought chiefly for its kerosene, which was used to illuminate homes. All else was regarded as by-products. Not much more than 75 years ago, kerosene and kerosene lamps were marvelous discoveries. People had been content with smoking, murky, whale-oil lamps or dim tallow candles. Kerosene by 1899 still formed 58 per cent of the products from petroleum. Only 65,000 barrels of kerosene were produced in the United States in 1937.

Part of the change in the use of petroleum has come from the replacement of the kerosene lamp by electricity, but far more important has been the astonishing development of the gas engine. The change has been so great that today gasoline makes up almost one half of petroleum products, fuel oil a quarter, and lubricants three per cent. Kerosene forms less than five per cent.



Here are stills and condensing boxes for refining petroleum and collecting its many products. In barely more than 30 years, petroleum has changed from a fuel used for lighting to one used primarily for power. At the present output of more than a billion barrels a year, our petroleum can last only a few years.

The growth in volume of the petroleum industry in the last thirty years has been unusual. In the forty years between 1860 and 1900 the total production of petroleum in the United States was only about one billion barrels. Now in one year the United States produces more than that—1,277,000,000 barrels, or five eighths of the whole world's output.

Of the two billion barrels produced in the world in 1939, North America produced 58 per cent; South America (Venezuela and Colombia), around 18 per cent; Russia, 10 per cent; Persia, 5 per cent, and Roumania, 3 per cent. The United States is as greatly favored in its supplies of petroleum as in its supplies of coal.

Colonel Drake's sixty-nine-foot well was considered an eighth wonder of the world in its time. Now more than twenty thousand wells are drilled in this country every year. Most of them are at least a thousand feet deep. Some reach down more than two

miles. There are over 600 oil refineries with a daily capacity of nearly four and a half million barrels.

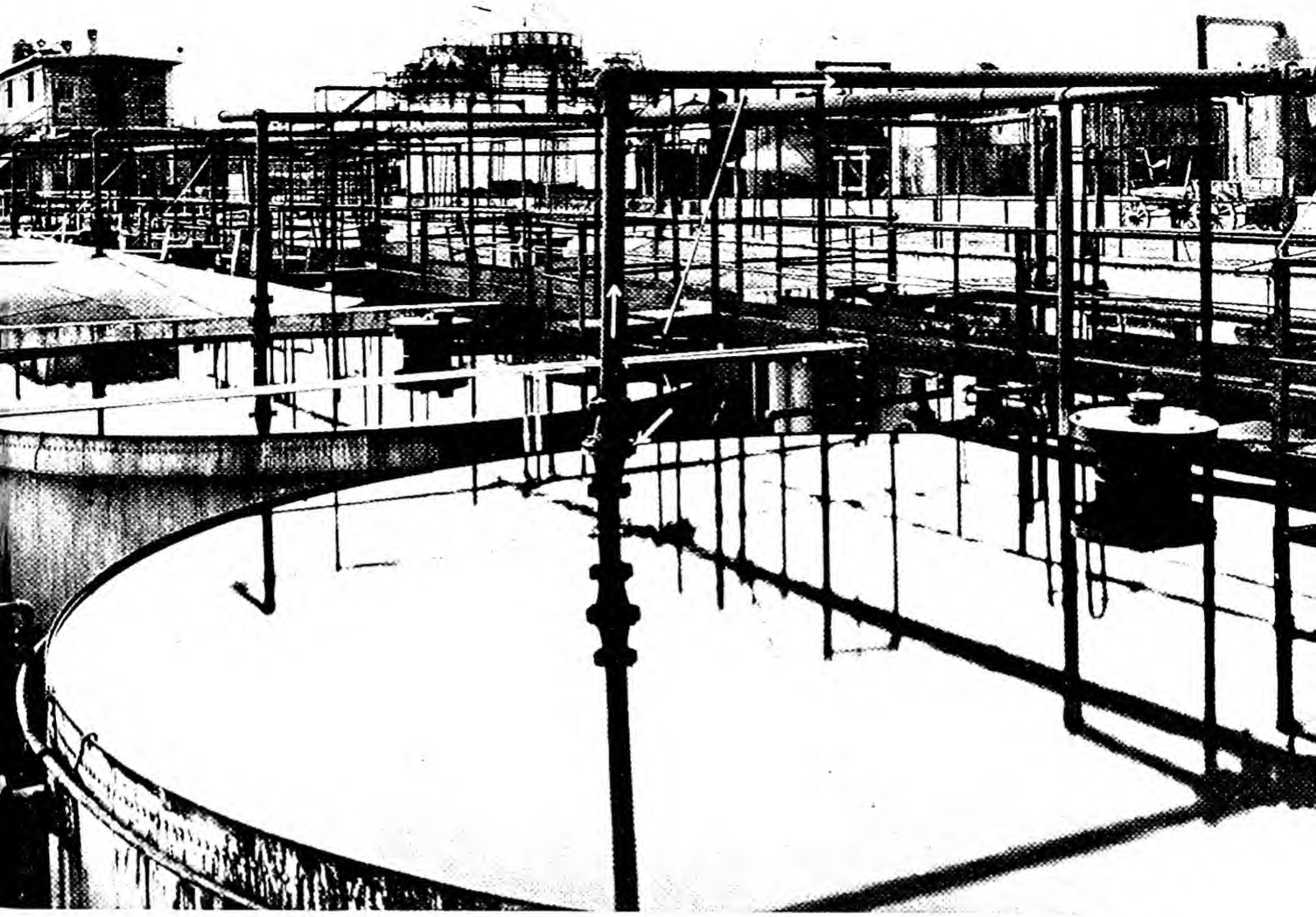
The low cost of gasoline in this country is largely the result of the large daily output, the methods of transportation, and the wide distribution of oil fields.

The United States is favored with oil fields in six general regions. (1) The Appalachian region extending from New York to Tennessee produces a petroleum with a paraffin base, as do all the regions east of the Mississippi. It is the best raw material for the manufacture of lubricating oil. (2) The Ohio-Indiana region reached its maximum production before 1900. (3) The mid-continental region including Kansas, Oklahoma, Texas, Arkansas, and northern Louisiana is the largest and most varied in the country. (4) The Gulf Coast region includes the coastal plain region of Texas and Louisiana. (5) The Rocky Mountain region includes Wyoming, New Mexico, and Montana. (6) The California region produces oil with an asphalt base, and is largely used for fuel oils and paving.

Since petroleum has been relatively cheap and widely distributed, men have used it unwisely. As already stated, wells were drilled almost at random wherever someone hoped there might be oil. Gushers came in when not expected and ran wild, flooding the surrounding land with oil. Wells caught fire and burned for days. Far more oil was wasted than ever was used. The mad rush to drill produced more oil than could be used. Since means of storing it were poor and transportation barely developed, a great deal more was wasted.

Science has been discovering some interesting facts about oil fields that are aiding in the conservation of petroleum. "Rock oil," as it was first called, comes from vegetable matter laid down, usually at the bottom of the ocean, covered with clay or sandstone, and buried in the earth for ages. Great pressure from heat and natural gas slowly forces the oil from the vegetation, and tiny globules of it seep into the surrounding sandstone. Being lighter than water, it rises. Much probably reaches the surface and escapes.

Only where this rising, migrating oil is trapped by a layer of impervious rock does it accumulate in considerable quantities. The overlying rock is often in the form of a dome, or what is

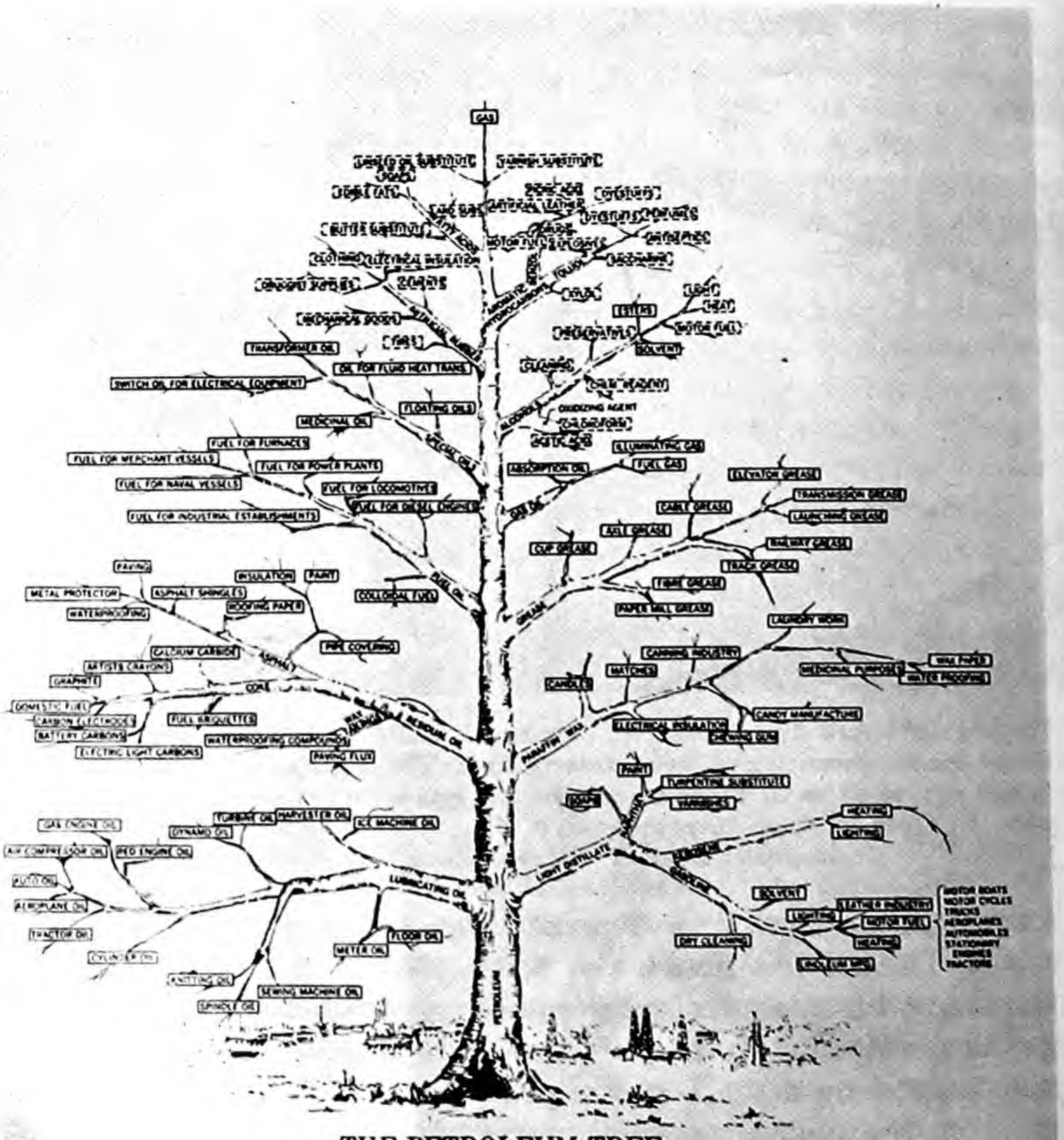


Each year more than twenty thousand wells are drilled for petroleum. Some reach down more than two miles. The crude oil is stored in great tanks equipped with pipes to collect the gas which used to escape into the air. In spite of such improvements, the best and safest storage is in the underground pools where nature has stored it.

known as an anticline. The bottom of the dome is filled with water. The oil lies above the water. Natural gas fills the top of the dome, often under great pressure. When the pressure of the gas is great enough, the oil well comes in as a "gusher" when it is tapped by a drill. If the pressure is low, the oil is pumped up from the pool.

As the well is drilled, a steel casing is sunk. If the well begins to gush, the casing is capped and the oil held in the ground. Great tanks are provided for storage and pipe lines are laid through which the crude oil is pumped to the refineries. Much less is wasted through wild wells than before. Almost a quarter of a million miles of pipe line transport the crude oil and products all over the country. The investment exceeds two and a half billion dollars.

Since the oil industry is young and many wells are being drilled each year, it is difficult to estimate the supply that may



THE PETROLEUM TREE
(Products obtainable from crude oil)
Dotted frames indicate probable future products

From a barrel of oil comes a multitude of products.

be available for the future. At the present rate of consumption there appears to be about fifteen to twenty years' supply in sight. This estimate may be greatly increased by new discoveries or it may fall short of the estimate.

In any event, the supply is certainly very limited. With many millions of years required for its preparation, there is no possibility of any more when what we have is gone. We must not waste our petroleum supply.

A glance at the wide range of valuable products from petroleum will illustrate the still greater need for wise use. Besides its uses as gasoline, lubricating and fuel oil, petroleum is used in making automobile tires, and is an important part of insect sprays.

When crude petroleum reaches the surface from underground, it contains a great many substances that pass off as gases when slightly warmed. When petroleum is heated to successively higher temperatures under high pressure and the gaseous compounds caught, the process is called "cracking." Improvements in the method have increased the amount of gasoline that can be removed from the crude oil by about 400 per cent. It will be interesting to discover the materials which are withdrawn in the process.

Conserving the Oil Supply

There are many means of combatting the great wastes of the petroleum industry, if they are only applied. There is no longer much excuse for gushers coming in unexpectedly and wasting oil. Science has discovered that by discharging dynamite and measuring the vibrations that travel in all directions from the explosion, the presence of domes and salt rock can be detected. A seismograph, the instrument used to record earthquake shocks, measures the vibrations. Electricity will also tell of the possible presence of oil deposits.

Originally only 10 to 20 per cent of the oil in a deposit was withdrawn before the well was abandoned. Now as high as 70 per cent can be extracted when compressed air is forced into the oil-bearing sands to take the place of the gas which would drive the oil out. Flooding wells with water to increase the pressure in surrounding wells is sometimes practiced.

The present methods of handling oil fields are very wasteful, both in the sense that the product is being lost and in the competitive methods of drilling wells. When oil is struck at some new location, drillers flock to the spot and hundreds of wells

are sunk in a frantic effort to tap the pool and draw off the bulk of the oil. The chances for very great profits lead men to produce far more oil than is desirable for the market. Overproduction, it has been shown, always means waste. Prices drop below where they should be, and wells are abandoned long before the oil is all extracted. When the supply of oil runs low, the same fields will most probably be redrilled at another great cost. There is pressing need for enforcing laws that will restrict the uncontrolled production of oil.

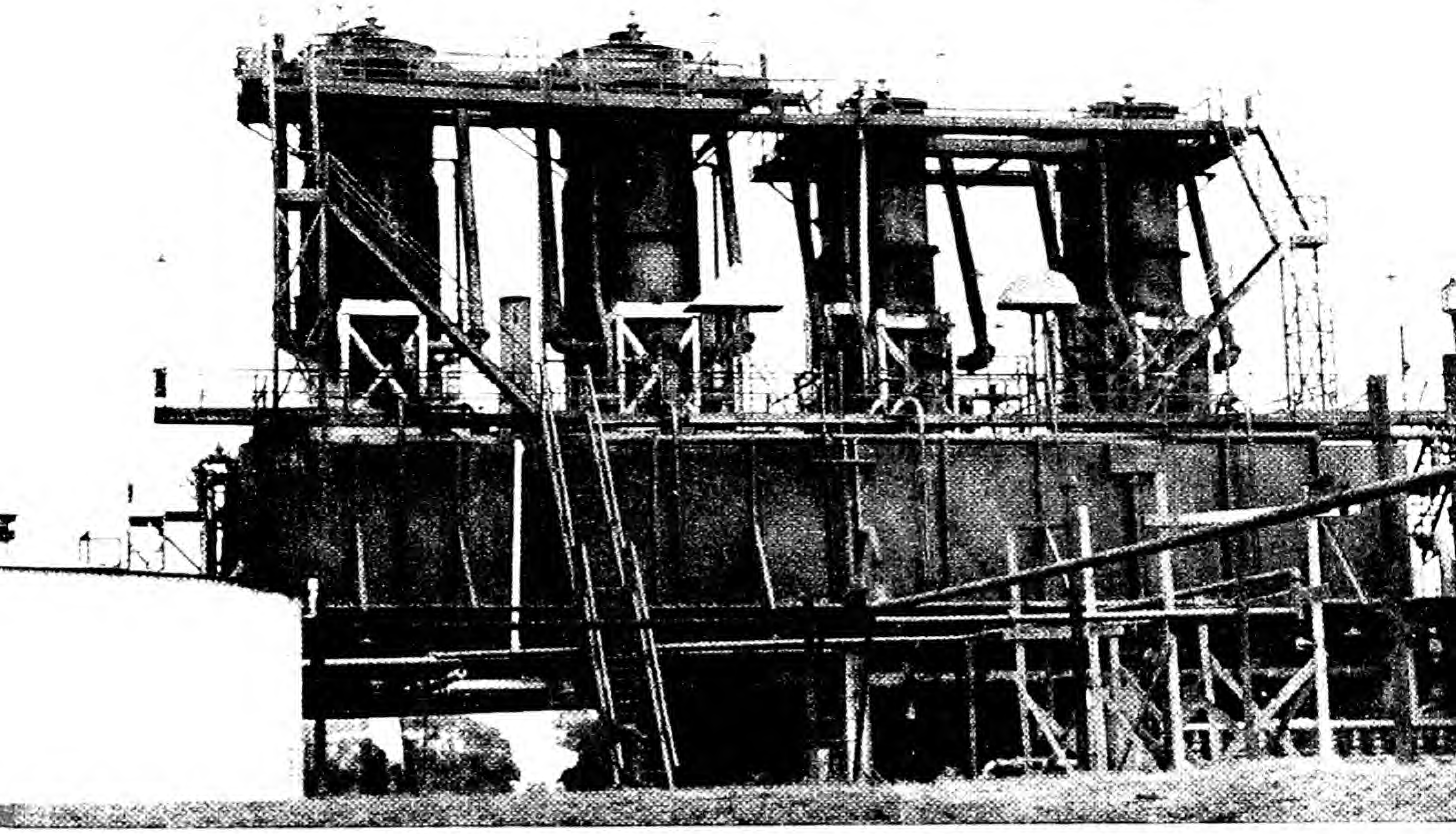
Another great waste of petroleum products has been the inefficient use of gasoline. The first gas engines and automobiles were notably inefficient. Most of the gasoline, rather than producing power, went out of the exhaust pipe as waste. At present, a greater percentage of the gasoline goes into power, but there is still room for improvement. If automobiles can be made that will travel twice as many miles to a gallon of gas as they now do, the supplies of oil would last far longer. A barrel of oil that might have been stored away until today would generate four times as many horse power as thirty years ago.

Another plan for conserving oil will undoubtedly be brought into action in the course of time when the cost of mining becomes greater. There is still much petroleum in shale. It has never been forced out of this rock by the forces of nature and it can not be obtained by a well. It can be extracted by heat distillation but the cost is great. Until the free petroleum is all used, the 92 billion barrels of oil locked within shale rock might just as well be left alone. It is good to know that this source is left.

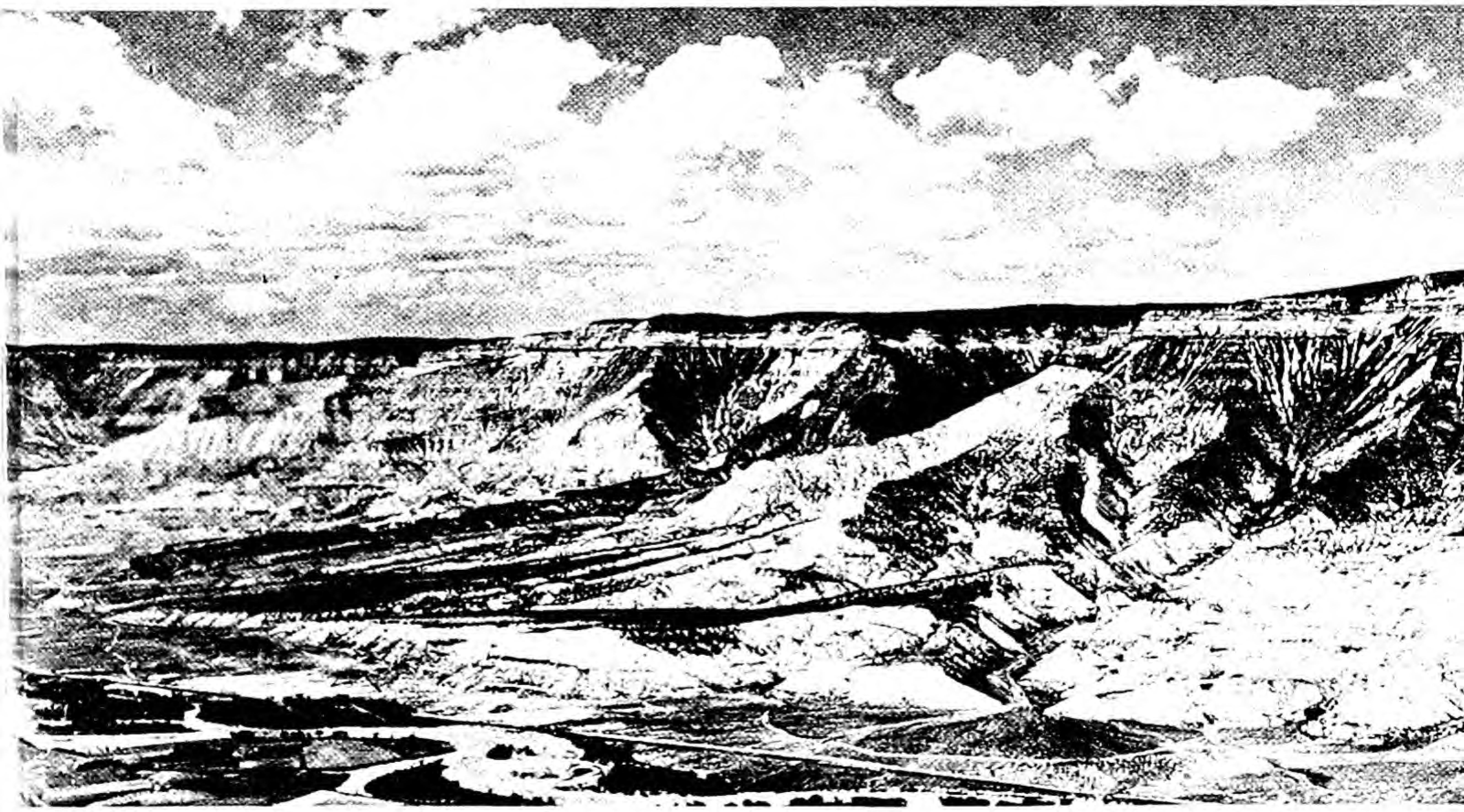
When even this supply fails, there may be need for other substitutes. The substitution of alcohol as now manufactured would be from three to ten times as expensive as gas. If it can be produced more cheaply in the future, it will be of great importance, since alcohol comes from renewable, organic substances. In Germany a gas derived from the hydrogenation of coal is being used quite satisfactorily.

But whether substitutes are effective or not, there is every reason for everyone to do all that he can to prolong the life of such a valuable resource.

Think what it would mean to the United States if all the cars in the country should all at once run out of gasoline!



Improved methods, among them the cracking process shown here, have increased the amount of gasoline that can be removed from crude oil by four times.



When oil wells run dry—and that time may not be far off—men will probably go to the clay shales for gasoline. The cost of extraction is still great, but better processes will be found. Here is a general view of the surroundings of the Bureau of Mines' shale plant at Rulison, Colorado.

Natural Gas

As already stated, natural gas is often associated with petroleum. It is in many ways the most ideal fuel that can be burned. It requires no refining and is ready to use as it comes from the earth. It can be piped for long distances. The pressure of the gas itself in a few fields furnishes the power to move it. It is easily ignited and the fire can be easily kept under control. The combustion is complete and leaves no ashes. Natural gas gives more heat than most artificial gas.

In the United States there are about a third of a million active gas wells. Their annual production has reached the prodigious figure of one and one half trillion cubic feet.

In earlier times certain difficulties limited the use of natural gas. Some water always condensed in the pipes. When they were not set below the frost line, the pipes froze during the winter and shut off the gas when it was most needed. Pipes laid at deeper levels and water traps remedied the trouble.

Any estimate of the supply of natural gas in the earth is uncertain. Some say it will last for a few decades; others say for two hundred years. Regardless of which may be correct, we know that it can not be increased. In this respect natural gas is like oil and coal. It must, therefore, not be wasted.

Unfortunately, natural gas is being wasted, and wasted shamefully. Wells are poorly capped, or not capped at all. The gas escapes by spouting out of uncontrolled wells and breaking out through fissures or openings that are tapped by the drilled wells. Sometimes this gas catches fire or is even set intentionally and allowed to burn for days. People come from miles around to see it.

Once in a while, if the gas is allowed to "blow" from a well long enough, the flow changes from gas to oil. At the start men thought nothing of letting all the gas blow. It was thought to have little value, but if allowed to escape, might permit the well to become an oil gusher of enormous worth.

What men did not realize was that the pressure of gas is necessary to drive oil out of its encasing rock. Millions of cubic feet of gas have been wasted and are being wasted as a consequence. One Government report tells of a field in the United

States where a billion feet of natural gas is being blown into the air every day. That is enough to supply all the present domestic users in the whole country, twice enough for Great Britain and forty times enough for the Scandinavian countries.

Just as in the case of oil, laws for regulating the opening of new fields and generally controlling production need to be enforced. Natural gas was formed long before man's time. Although the wells may be owned by private interests, natural gas is a national asset. Waste of it in any way should not be permitted.

For still another reason, gas ought not to be wasted. When gas is pumped back into the well it helps recover more petroleum, and the gas is stored in the ground for future use. Another possibility for its conservation might be to encourage greater use. Using more of a substance seems a strange conservation practice; but, if the production of oil and gas were balanced, less gas might be wasted through lack of demand for it. It would be well to prohibit boring more wells until preparations have been made for the use or safe storage of gas.

The Metals

Metals have been in use much longer than the fuels, coal, petroleum, and gas. So important were the metals from which man made his tools that history has named a stage of civilization for each material. Thus the earliest man of whom we have knowledge lived in the "stone age." All his crude tools and weapons were made of stone.

But stone was hard to work with. When some man chanced upon copper in fairly pure form, he found it could be readily fashioned into desirable forms, but was a little too soft. In the course of time he found that copper could be hardened by mixing it with tin. The result was bronze and the "bronze age." This material was tougher but it could not be tempered.

As the bronze-age man learned how to handle fire and concentrate heat, he learned to smelt the ores into metals, particularly iron. So the "iron age" began. The success with iron led men to experiment with mixtures. When carbon was mixed with iron, a metal resulted that had great qualities of strength and elasticity. The world is still said to be in the iron age. By proper

mixtures or alloys of iron with other substances, it is possible to develop materials for a great many purposes.

Metals are not very evenly distributed throughout the earth's crust. Some nations are richly blessed with metal resources; others are without any. No nation has a monopoly on metals, but the United States leads the world in the production of eight of the seventeen most essential metals. Together the United States and Great Britain control at least 70 per cent of sixteen of them. The North Atlantic basin is the most richly endowed region in the world in the matter of metals. As a result the most powerful nations of the world lie around it.

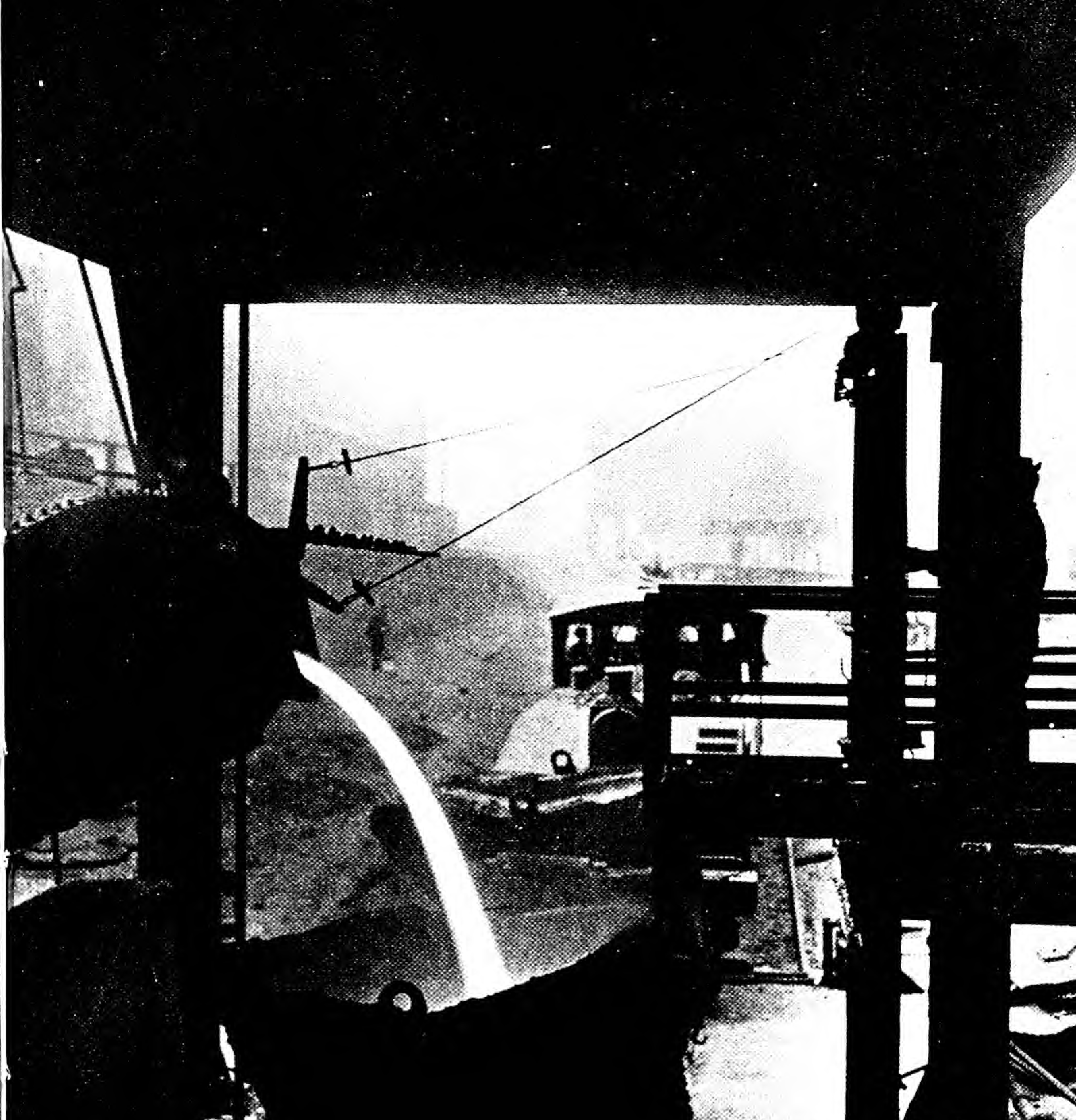
Let us compare the use of a few of the better known metals for the period from 1800-1850 with the period 1921-1930. The production of lead has increased 21 times; copper, 52 times; zinc, 96 times; gold, 24 times; and silver, 11 times. Moreover, considerable amounts of other metals have been used in the latter period that had never been known or used in earlier times. Metals and combinations of metals or alloys have brought about an age of commercial development previously unknown in the world. In 25 years agricultural production increased 17 per cent. During the same years the use of metals increased 77 per cent.

What are the principal or major metals?

Iron

Iron without question heads the list. Although gold has been chosen by many nations as a measure of value, iron has been the most important metal in the development of modern civilization. It has made possible the making of precision machinery. Without a metal that can be easily molded into accurately measured parts, the manufacture of machinery on the modern scale would have been practically impossible.

Iron is widely distributed and next to the most abundant of all the metals. There are three great iron centers: the United States, which produces almost half of the world's supply; France and Germany, with about 35 per cent; and Great Britain, producing about 10 per cent. In recent years the development of mines in Russia has placed that country ahead of Great Britain. What little iron is mined and smelted outside of these countries is mostly for domestic use. Brazil, however, has enormous de-



This is an age of iron. A modern civilization depends upon iron and steel for the skeletons of its great buildings, for its automobiles and tractors, and for its amazing machines. This smelter is in Pennsylvania

posits of high-grade iron ore easily available and now being developed.

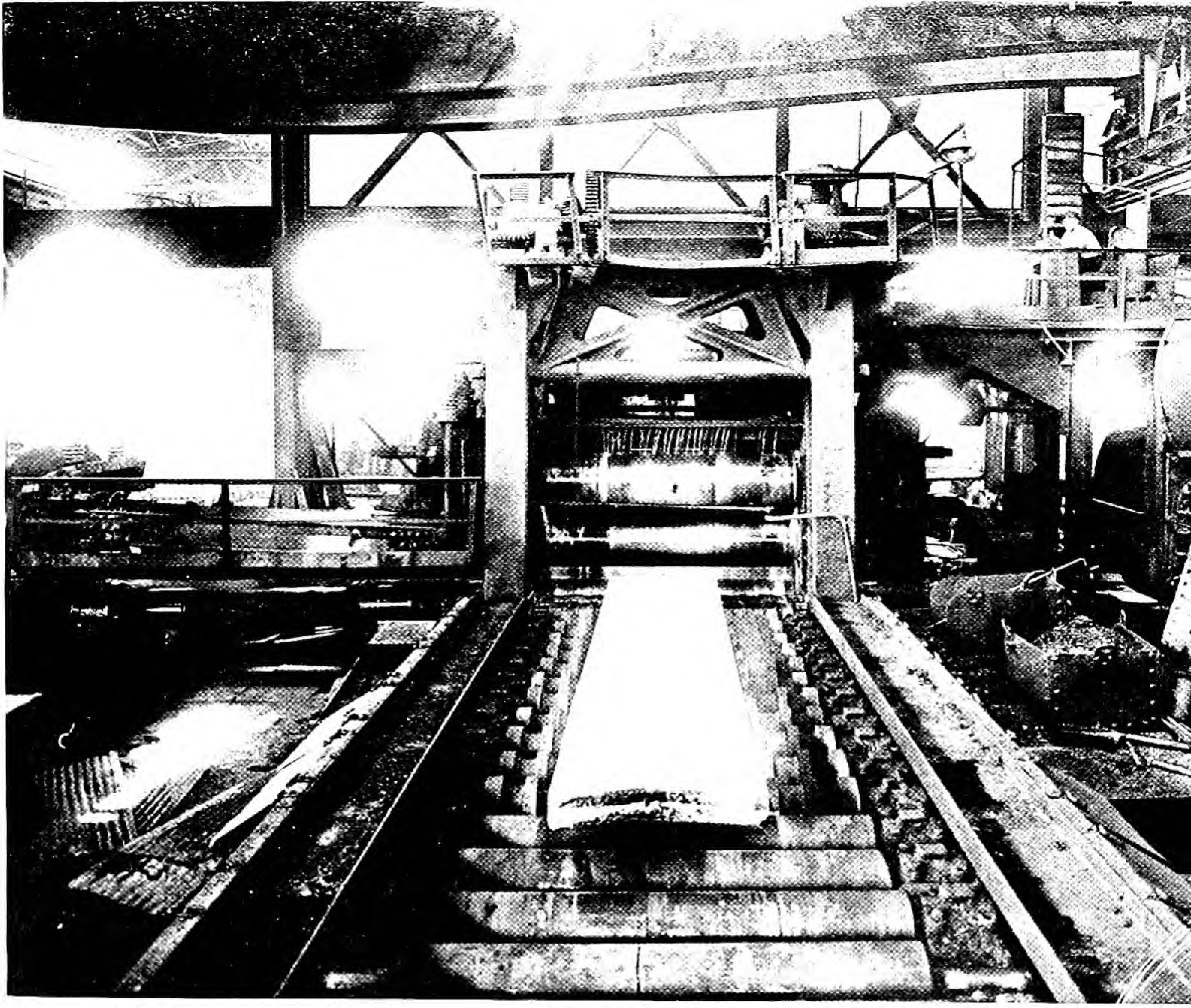
The first iron smelter was established in Virginia in 1714. It was called a "bloomery" because it made masses of metal called "blooms." The output was very small, partly because there was no proper fuel to sustain the great heat necessary. The introduction of coke about 1750 greatly stimulated iron production.

The steam engine of around 1770 proved another spur to the iron industry. Power machines of iron came into use. Locomotives called for iron rails. When trains began to travel faster than a man could run, something stronger, tougher and more elastic was needed to stand the strain. Steel was the answer. Steel proved many times more useful than iron. Later as technical knowledge increased, alloys were made with chromium, molybdenum, vanadium, and other metals, each one of which was fitted to some special purpose.

So much coal is used in converting iron ore into usable products that places where both coal and iron are found have a great advantage. Thus far only two such regions have been developed: northern Alabama, and to a lesser extent, western Pennsylvania, with centers at the two great steel cities of Birmingham and Pittsburgh. It is cheaper to ship iron ore from other sections to those centers than to ship the coal out.

The supply of iron ore is enormous. There is little prospect of its exhaustion within our lifetime, but iron is, nevertheless, a nonrenewable resource. The United States at various times has produced nearly half of all the iron in the world. Will it always continue to do so? If this nation is to maintain its greatness, it must use its iron wisely.

What are the aspects of the conservation of iron? Iron ore is of many grades of richness. Most of what is being mined and smelted at present is so pure that it can be sent directly to the smelters without any preparation. Such ore is definitely limited in quantity. Possibly half of that of the Mesabi has been used by 1940 and there is not much more than enough left to last thirty years. The great share of iron is of a lower grade. It contains impurities which require that it be put through a concentration process before being shipped to the smelter. Naturally this means that the cost of producing a ton of iron from the



Iron coated with zinc or tin will resist rusting. Paint or oil also covers iron with a protecting coat. When no longer useful, iron should be sent as junk to the smelter to be refined and rolled out for new usefulness.

lower grade is greater than what would be required for the rich ore. Science has already worked out methods for the use of low grade ore.

A wise step towards conserving the rich grades would be to mix them with the lower grades, and thus gradually shift to the use of the lower grades. This is being done to a certain extent. In Europe much low-grade ore is now being smelted.

Iron very quickly oxidizes or rusts unless it is kept painted or covered with oil. Rust is particularly active when iron is left outdoors in the rain and sun. Iron that is galvanized with a coating of zinc or tin will resist oxidation. On high grade instruments iron can be coated with chromium to form a rustless surface.

Although iron is nonrenewable, it is re-usable. The junk man who collects scrap iron is performing an important service in conservation. In some years more than half of the iron used in manufacturing steel comes from scrap.

Another worthy practice would be to substitute wood and aluminum where such substitutions can be made safely and economically. Sometimes necessity finds a better way.

Copper

Copper got its name from the island of Cyprus, off the coast of Asia Minor, where it was first found. Copper was probably one of the first materials which man learned to use. It can be easily extracted from the native ore at fairly low temperatures, is tough, malleable, and does not rust.

Copper is found in the following states: Montana, Arizona, Michigan, Utah, California, Tennessee, and Nevada. In 1872 the United States production was only 15,200 tons; in 1900 it was 275,000 tons; by 1909 it was over 500,000 tons, close to three fifths of the entire world production. This country has produced up to 830,000,000 tons. Other important copper-producing countries are Chile, Rhodesia, Canada, Belgian Congo, Russia, Japan, and Germany.

The great increase in the use of copper since 1900 is due to the greatly increased use of electricity. Next to silver, it is the best conductor of electricity as well as heat. Long distance telephone lines, and thousands of miles of high-power transmission lines have taken many tons of copper. The electrical industry as a whole uses about one half of the copper produced.

Copper roofs, copper rainspouts and copper screens are coming into wider use. Since the metal oxidizes or rusts very slowly either in air or water, copper is practically everlasting. The Federal Government has used it in monuments to mark the boundary line between Canada and the United States.

Copper is one of the very valuable resources. Like iron, it is an unreplaceable asset, but it is not plentiful. Careful use, both in the mine and in the factory, is a conservation measure which is being studied carefully. On account of its durability a great deal of scrap copper is used. Some day there may be enough copper mined so that the re-use of scrap may supply the

At one time only half the copper was saved in mining. Now with highly developed processes up to 95 per cent is recovered. Scene in Utah.

greater part of the nation's needs. Indeed this has already come near to fulfillment. One year 31 per cent more metal came from scrap than from ore.

There is usually an overproduction of copper in the United States, and under such conditions conservation is difficult. Almost $100,000,000 worth of copper is exported annually.

Any metal which has such highly specialized uses—that may be mixed with zinc to form brass and with tin to make bronze, two very valuable alloys, and that has many fine properties—should be reserved for its best uses only. Other metals which are more abundant should be substituted wherever possible.

Gold

Gold has been known since the earliest ages. Almost every country has found some gold in its earth, but only a few have found any appreciable quantities. Because it is scarce and is resistant to the action of air and common acids, it has been

accepted almost everywhere as a standard of value. It has been minted into money by almost every civilized nation. The United States Treasury is now holding more than nineteen billion dollars in gold, 70 per cent of all monetary gold in the world.

The most famous gold fields are located in South Africa, the United States, Canada, Russia, the South American countries of

In placer mining, gold is washed out of gravel in small nuggets.

Colombia, Brazil, Chile, and Australia. The most important producers among the states are California, Colorado, Nevada, South Dakota, Utah, and Alaska. The Homestake mine at Lead, South Dakota, is the largest gold mine in the United States.

Progress has been great in discovering better methods of extracting gold. About 30 years ago ores carrying ⅛ ounce of gold to the ton were thought to be low grade. Now gold ore can be profitably worked that contains only half that much. Part of this change may be caused by the increase in its value.

Thousands of dollars' worth of gold used to be wasted in "wear and tear" when gold coins were used for money. Paper money serves the purpose just as well. The gold can be more profitably used in the arts, for dental work, and other places where nothing else will serve. When used as coin or jewelry it is combined with some harder metal that withstands wear.

Silver

Because of its shining whiteness, silver was called Luna or Diana by the ancient alchemist who tried to make it from some of the less rare metals.

Today the United States mines around 60 million ounces and together with Mexico produces two thirds of the world output. Most American silver is shipped to China and India to support the silver money standard in those countries. The chief commercial use is in photography and especially the moving picture industry. Considerable quantities are used in the arts for tableware and ornamental purposes.

Silver is harder than gold, but not so hard as copper. It is the best known conductor of heat and electricity. It is so soft that it must be mixed with copper when it is used for money or any other purpose where it will be roughly handled. At the rate silver is being mined, the end of its supply is already in sight. Here is another challenge to active conservationists. Silver must be put to use where it will not be lost.

Lead

Lead seems to have been widely known among ancient peoples. It has been in constant use ever since. The Romans used lead for water pipes and coffins. Tamerlane in 1400 piped spring water in lead pipes to all parts of his capital city of Samarkand.

By far the greatest part of lead is used as white and red lead in the manufacture of paint. Its next largest use is for the negative poles of electrical batteries. Lead pipe and plumbing supplies take most of the remainder. Babbitt, a nonfriction metal, is an alloy of lead that is much used for bearings in machinery. It is much used for covering cables. Some excellent carving has been done in the metal.

Lead is rather widely distributed. It occurs in considerable quantities in the United States, Mexico, Australia, Germany, Spain, North Africa, Brazil, and India. The United States, Mexico, Australia, and Spain produce more than two thirds of the world's supply. The mines in southeastern Missouri are the largest in the world. Ore veins there are 300 to 800 feet thick and extend over thousands of acres.

Leadville, Colorado, an important center, has had an interesting history. One year after gold was discovered there it had a population of more than 5,000, and the census of 1861 showed it to be the largest town in the state. The mine proved to be a shallow placer. Five million dollars' worth of gold was removed and the town dwindled to a village.

In 1874, A. B. Wood discovered lead there in large quantities. In 1878 the town was reorganized and given its present name. A railroad was built to it in 1880, and the village jumped to a city of 35,000. Almost always some silver is found in lead ore; here there was enough to make it the more valuable part. Thirty active mines and ten smelters were operated. Prosperity stayed with Leadville until 1893, when the price of silver dropped. But, even then, Leadville did not die. Zinc became an important product. The city turned its activities to zinc, and in 1915 that metal made up 65 per cent of its product.

Unfortunately for the conservation of lead, much of it, when used in industry, is not recoverable. That used in making paint, about a third of all that is produced, is lost for all time. On the other hand, lead in pipes is rapidly being replaced by iron. When used in manufacturing glass and in making ethyl gasoline, lead is again, unfortunately, lost beyond recovery.

Lead with its oxides and alloys has come to play a very important part in present-day civilization. Like copper it is almost indestructible and can be reworked in many instances. At best, however, the supply of lead is limited to only a few years. Some estimate it will last less than ten years. In that time, conservationists will need, if it is possible, to develop other materials to take its place. More important for the immediate future, lead will need to be used wisely to prolong the date when the metal will no longer be in the range of usefulness.

The substitution of a clear, colorless paper made from wood for lead foil has done much for the conservation of lead. A good substitute for lead in paint—possibly titanium ore—would be a most important step.

Zinc

Compared with many other metals, zinc is a mere child in its years of common use. It was first smelted in England about

fifty years before the American Revolution. Today the United States produces 36 per cent of the world's supply. Belgium is second and Poland third.

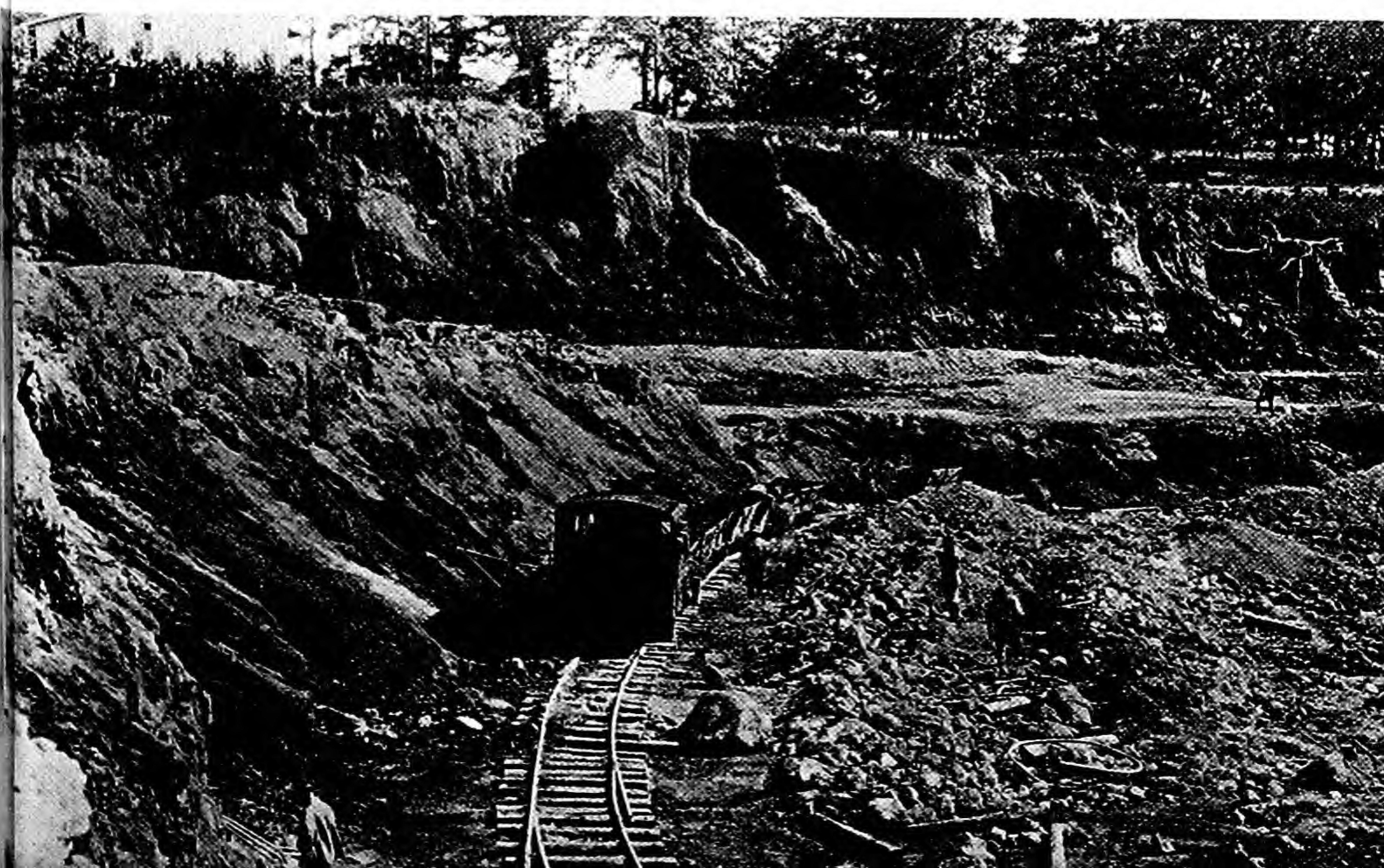
Zinc is nearly always used in mixtures with other metals, usually in the form of alloys. Its most important uses are for galvanizing and in paints. In both cases the zinc is lost beyond recovery.

There are dozens of other metals, each of importance in its field, but the foregoing are of such great value that they have been called the "Big Six" of the metal kingdom.

Aluminum

Aluminum is a metal already knocking for admission to the kingdom of major metals. Mention has been made of its possibilities for replacing other metals whose supplies run low. One of the comparatively late discoveries among the metals, aluminum occurs in small quantities in combination with clay, shale, slate, and several other rocks almost everywhere over the earth's crust. It is said to constitute eight per cent of the solid portion

Eight per cent of the solid portion of the earth's crust is made up of aluminum, the most abundant metal. Only a small part of this supply can be profitably extracted at present. If better means of mining and smelting can be found, aluminum may keep the world going when other metals fail. Scene shown below is at Bauxite, Arkansas.



Its light weight makes aluminum well suited to airplane construction. [illegible] and transport planes now have aluminum propellers and bodies. Here is a propeller being taken from a mold.

of the earth's surface to a depth of ten miles. Aluminum was first reduced to a metallic form from some clays found near Les Baux, France. The ore is consequently called bauxite. Its commercial production began in the United States a little more than fifty years ago.

Pure aluminum is so soft that alone it finds comparatively few uses. Alloyed with copper, magnesium, and manganese, it possesses great strength and is able to compete with copper and iron. It has about one third the weight of iron, is a good conductor of heat and electricity, and does not suffer from oxidation.

Since the cost of aluminum has been reduced by improved processes its uses have been increasing by leaps and bounds. Men in industry expect it may replace many of the rarer metals—including iron, copper and silver—for a variety of uses, particularly when the supplies of these metals run low. Combined with silica (sand), it is strong enough to supplant iron and steel in construction work. Its lightness makes it ideal for airplane construction and streamlined trains. Aluminum plating can be substituted for galvanizing on wires and flat surfaces.

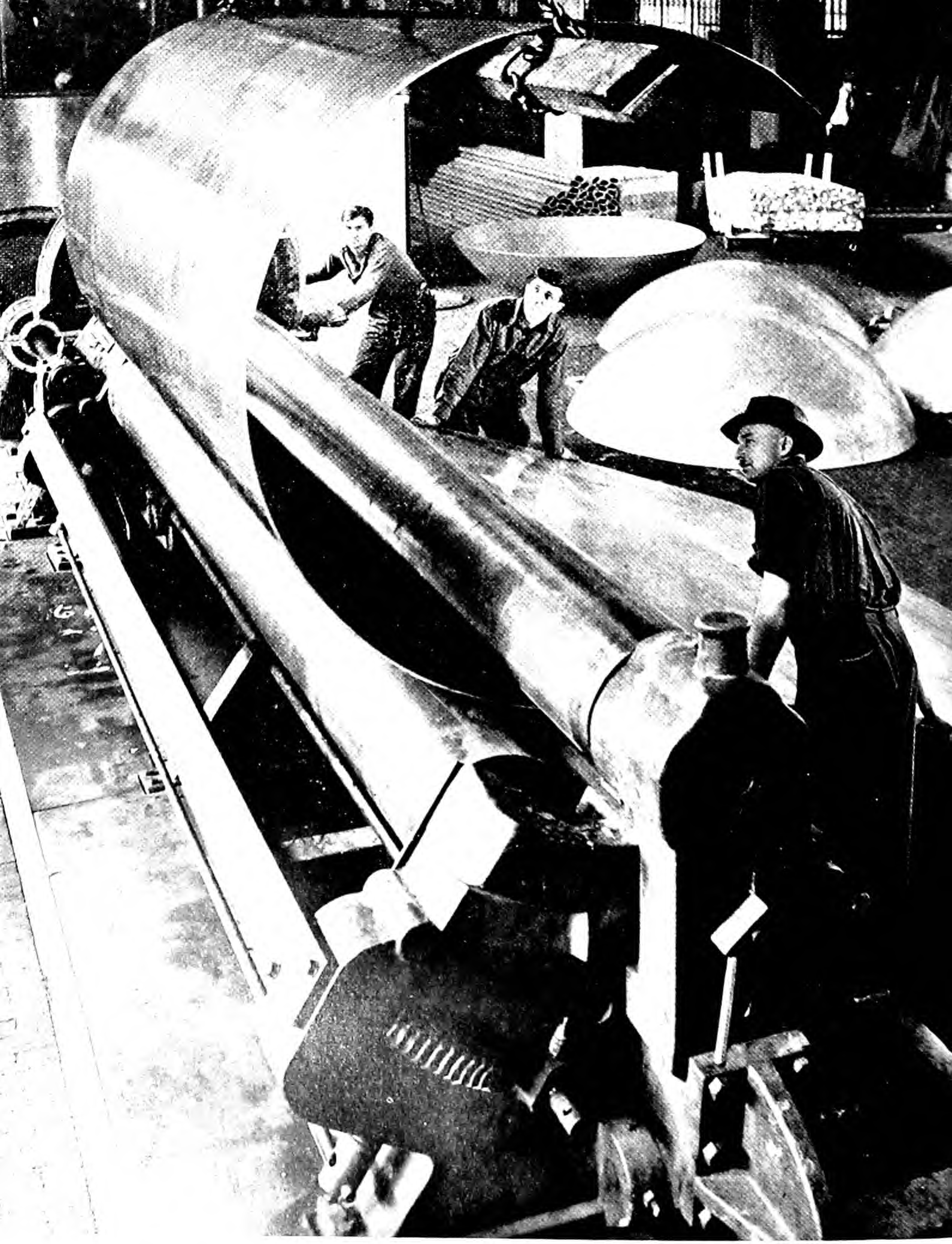
Minor Metals

It is difficult to predict the future in any field that is changing as rapidly as the development of the metals. A few of the minor metals have been the basis for a great deal of careful study during the past few years. Some metals show great promise of importance in the future.

The production of beryllium is very small in the United States at present. The metal has recently acquired new importance for use in munitions and in certain vital parts of airplane engines. It promises to have other uses in alloys with copper, nickel, and other metals.

Calcium as an alloy with steel is increasing rapidly. It is an important element in the manufacture of stainless steel, which is finding great use in kitchen instruments and in construction. Any new use that can be made of calcium is fine conservation, since the earth abounds in the limestone which furnishes calcium.

Chromium, columbium, and tantalum are other ingredients of various kinds of stainless steel. Their use is increasing rapidly. Indium may be used in dental fillings and in coloring glass.



Every time sheets of cold aluminum are passed between heavy rollers, the metal is hardened.

Mesothorium is finding increased use as a radioactive substance. The magical radium is constantly finding new uses. It is now used to detect flaws in metals and in the treatment of certain diseases.

Manganese and molybdenum are of importance in alloying with steel to produce a metal of extreme hardness. Tungsten, another important metal, must be carefully managed to conserve the domestic supply.

One of the hopes for conservation of the important metals lies in substitution of renewable nonminerals for the nonrenewable minerals. Among the most promising substitutes are the new products made from cellulose or plant fibers called "plastics." They are made from many different materials, any one of which is renewable. Soybean oil is an important source of plastics.

New uses for plastics are being found every day. Whenever a renewable product can take the place of a nonrenewable one, there is a gain to conservation.

The Nonmetals

Besides the fuels and metals, a next large division of minerals may be called the nonmetals. These include building materials, fertilizers, and valuable chemicals.

Most building materials, such as granite, sandstone, limestone, marble, and slate are practically inexhaustible. Whenever possible, they ought to be substituted for metals. Concrete walls may take the place of steel girders, slate and tile roofing may take the place of copper, and bricks may find still wider use in construction. Every man who is interested in mineral conservation ought to feel happy whenever he sees the common and inexpensive nonmetals take the place of the metals. Clay, too, is abundant. The soft white kaolin of southeastern states is valuable in making white tile, electrical porcelain, and fine china.

The minerals which have value as fertilizers constitute a very important group. If the valuable soil resources are to be kept in production, many of them will need refreshing from time to time with some of the vital elements which support plant life.

Soft kaolin is found in several southeastern states. After being freed of impurities, it is made into white tile, electrical porcelain, and fine china.

The most important fertilizers contain nitrogen, potassium, phosphorus, and calcium.

The United States at one time was dependent on the nitrates of Chile for the nitrogen supply. During the World War of 1918, scientists discovered how to capture nitrogen from the air by means of electricity. The Government plant at Muscle Shoals on the Tennessee River could, if necessary, supply all the nitrates needed for an indefinite period.

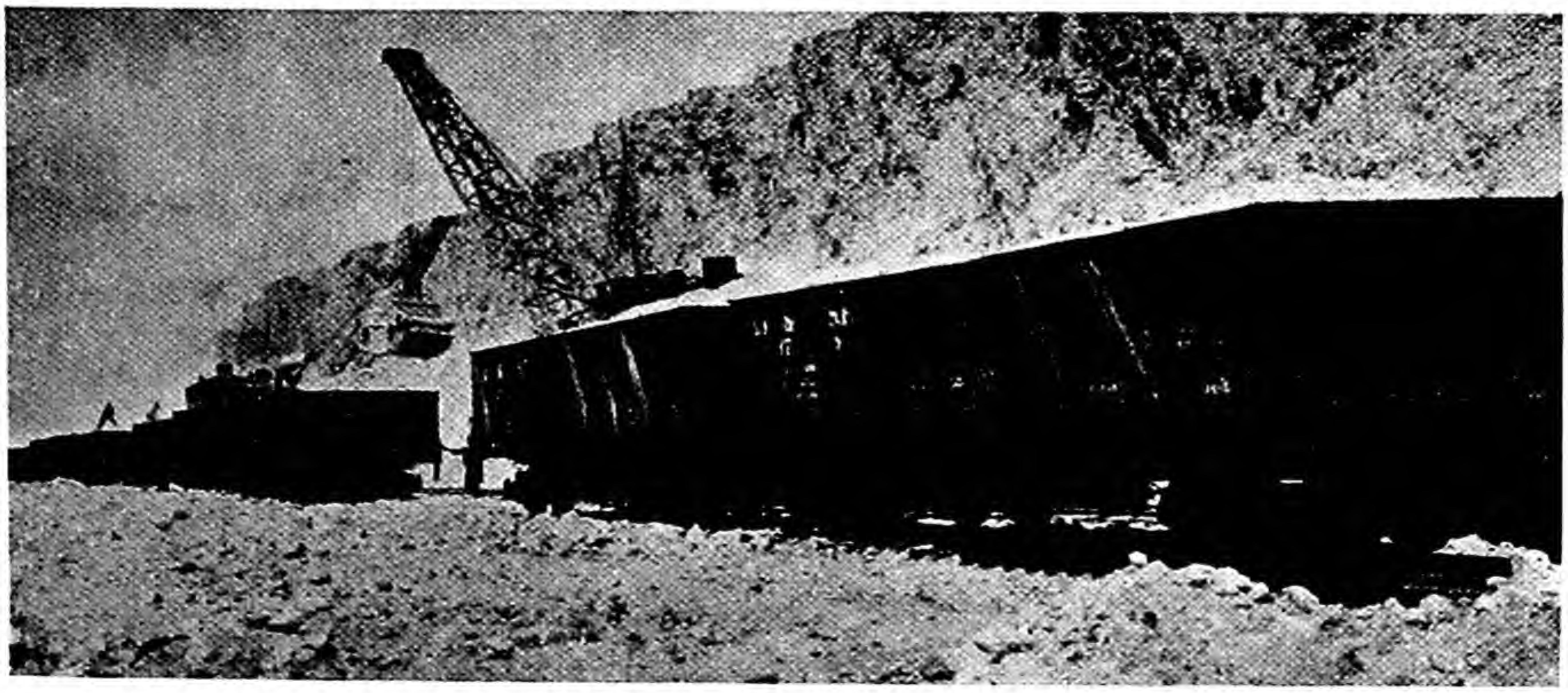
The large deposits of potash in New Mexico, which now supply much of the potassium, are now under state and Federal management. Production is carefully regulated to meet the demands of the market. The phosphate rock deposits in Florida have endowed us with a good supply of phosphorus. The western mountain states of Idaho, Wyoming, Utah, and Montana perhaps

contain even greater stores. Although the great bulk of phosphate goes into fertilizers, some is made into red phosphorus for matches, and some into paint to make objects luminous at night. The supplies of limestone which furnish calcium seem at the present to be almost inexhaustible.

The United States possesses an abundance of chemical substances which are widely used. Salt is an important one, and seems to be almost unlimited in supply, in spite of the very great use made of it. Sulphur, used in making sulphuric acid, in making matches, insecticides and fungicides, medicines, and for many other purposes, is present in large deposits. This country supplies something like 95 per cent of the world's production of borax. Much of this substance is at present being exported to other countries. The deposits ought to be carefully conserved.

The General Problem

The conservation of minerals in general falls into three main divisions: careful use to avoid waste; better processing to bring about more complete utilization; the substitution of the more plentiful for the rarer and the use of the rarer for the purposes to which they are best suited.



Sulphur is the basis for several industries. Most of the supply in the United States, the world's largest producer, comes from great deposits in Texas and Louisiana.

We must enforce the cleaner mining of coal and iron and other minerals so that all usable ore will be extracted before mine waste and water lock the entrance. We must control the drilling of oil wells so that too many will not be opened up. We must see that all oil and gas are mined with the least possible waste. Every metal ought to be used and re-used and re-used until there is nothing left of it.

We must make certain that the best process known is applied in refining each mineral. The flotation process has made possible the use of millions of tons of low grade ore and the cracking process has saved us millions of gallons of gasoline. But there are still many more savings that will be discovered by careful study. We must not be satisfied until every one of our minerals is put to its very highest use.

When we shall have done all these things, we shall have no regrets when our mineral treasures are finally gone.

REVIEW QUESTIONS

1. How are minerals often wasted?
2. What is the chief difference between minerals and other resources?
3. How has iron mining changed in the last few years? What does the history of iron mining reveal about minerals in general?
4. What are the forces which are postponing the day of final exhaustion. Those which hasten the day?
5. How does harmful competition result in wastes?
6. Why is one metal often substituted for another? What need is there for re-using metals?
7. How long will our coal supply last? Fifty years from now, which grades will probably be most important?
8. In what ways has the petroleum industry changed?
9. What are the chief losses in recovering oil? How are they being reduced?
10. Describe the formation of oil and gas in an anticline.
11. How is natural gas performing a useful service even when it is not tapped for burning?
12. Discuss a program for making complete and best use of oil.
13. What wastes are robbing the nation of its supply of natural gas? How can they be prevented?
14. Study again the increase in use of the common metals. What do these figures probably indicate regarding the stage of use of each?
15. What factors kept iron from being quickly developed?
16. Which of the uses of copper allow it to be re-used? How would you prolong the life of our copper supply?

17. Of the purposes for which gold is used, which ones allow recovery?
18. Why is conservation of lead difficult? What measures might be taken to prolong the supply?
19. Why is aluminum, in spite of its abundance, not being used more widely than at present?
20. In what places would you expect to see aluminum take the place of other metals? Which metals might be partially replaced by it?
21. To what uses are the nonmetals put? Where may the building materials substitute for the metals?
22. If erosion continues to destroy the productivity of land, how can the fertilizers help remedy the trouble?

SUGGESTED ACTIVITIES

1. Draw a careful chart of the principal metals. After the name of each, fill in its principal characteristics, hardness, melting point, and conductivity. Next list its most valuable quality. What is the highest use that can be made of each? Which may be substituted for another? Collect samples of the major and minor metals.
2. Figure how much it costs to heat your home. What kind of fuel is used? What economies might be started which would conserve the fuel you are using? How many tons of coal are needed to keep your community warm?
3. From your gasoline station attendant find out whether there has been an increase in the use of gasoline during the last ten years. Suggest a program for conserving gasoline.
4. From encyclopedias, government pamphlets, and bulletins, find all you can about the amount of gasoline in oil shale. How is it extracted? How costly would its recovery be?
5. Make a survey of the minerals which are produced by your county or state. How much revenue do they add to the locality? How long will the supply of your minerals last? What might the mine, quarry, or oil field workers do when the mineral supply is exhausted?
6. Follow in the newspapers articles and news items concerned with minerals. What practices can you see are being put into effect?
7. Study one of the new minerals or metals. What are its properties? Does either its abundance or its usefulness make it a worthy subject for conservation study? For what purposes might it be used?
8. Visit a local gravel pit, quarry, oil field, coal or metal mine. Write an account of the evidences you find of waste. Does there seem to be need for more careful use of the mineral? Formulate a program for conserving it.
9. Look through your home, farm, or vacant lot for scrap iron and copper that can be re-used. Such scrap can be sold for a profit. Some people believe that the time is not far removed when dump yards will be mined for the metals they contain. Find out what other scrap metal can be sold.

Debate: Resolved, That copper should be more widely used, so that there will be no overproduction of the metal.

CHAPTER NINE

The Human Resource

DID YOU EVER stop to think what you are worth? Not what your mother or your father or you believe you are worth. Leaving out sentiment and opinion entirely, just how much are you worth to your nation in cold cash?

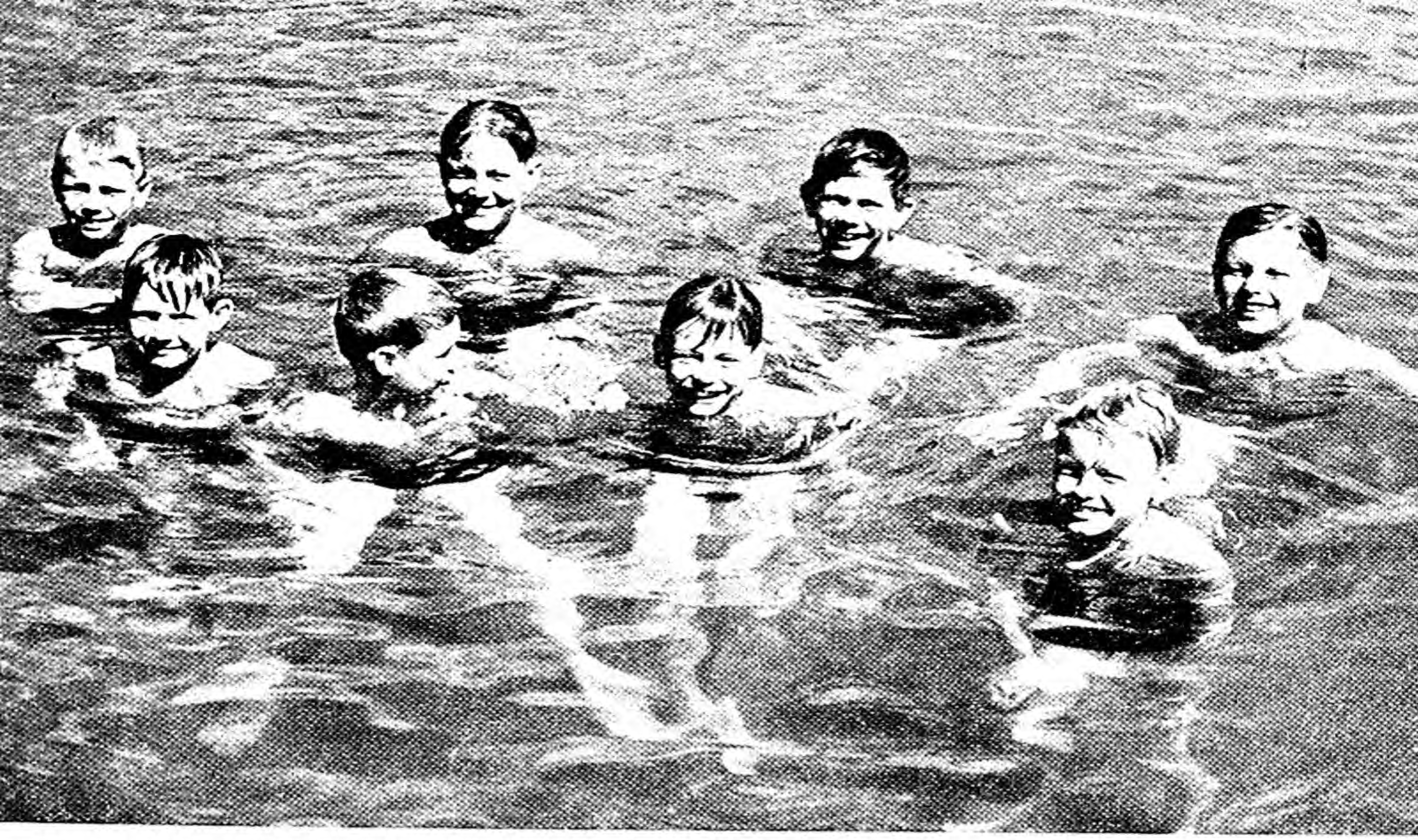
Society has a large investment in you, and in every boy or girl who is almost ready for work. It may not sound very flattering, but at present you are a liability rather than an asset to the nation. Your parents or your guardian, and the state have invested quite a sum of money in you; somewhere between four and six thousand dollars. By the time you have reached your eighteenth year the cost will be twice that much. When you reach eighteen you are really in debt to society. Man power is the costliest crop in the world to produce.

Perhaps you think you are worth something while you are growing up, but your real value to the nation is the work that you do—no more, no less. Some statisticians have figured that the present value of all the work that you will ever do is about $6,000! That is what your work would be worth now if all the money that you will earn in the future is discounted back to the present time. On that basis the present man power of the nation may be capitalized at over $800,000,000,000.

It is hard to believe that work could be worth that much. But there is a lot of work done in the nation. If one will only think of the work that a single man can do in a day driving shingle nails, and then multiply that by a hundred million, one can get some conception at least of the enormity of the work that would be done. The shingle nails would give out long before the day was over.

A nation's working people constitute its man power. Together with the children not yet of working age, they constitute the human resource.

Just what is the character of this human resource?



Man power of the future.

The human resource is extremely valuable. Perhaps its great worth lies in large part in the fact that it can be used for such a variety of purposes. It can build bridges, fly airplanes, paint pictures, run complicated machines, and teach others how to perform valuable work. Although a resource like iron has very definite uses, the uses of man power are almost limitless.

Man power is not only the most valuable resource; it is also the most perishable and the most easily destroyed. Just as erosion robs land of its fertile topsoil, so there are forces ready to set upon man power to lessen its value. Some of the worst of these forces are wars, plagues, accidents, lack of physical health, and mental unrest.

War is probably the greatest catastrophe that can befall a nation, whether the nation wins or loses. It has been pointed out that war drives men to waste all the resources. It causes them to squander their minerals, rip open their grasslands, and strip off their forests. But, much worse still, war wipes out great numbers of healthy men, upsets their government, destroys their hopes and plans, and leaves them burdened with the care of thousands of invalids.

The actual loss of human resources may be shown in greater detail. A crop of humans is born, fed, clothed, educated, and given medical attention, at great expense in effort and money.

In any generation, the large share of men and women will be average workers, people whose contribution to the nation will be in doing average jobs, but jobs which someone must do. A few will be men and women of special talents who will find places of responsibility in business, in the arts, and the professions. A very small proportion will be geniuses, men and women whose minds will give to the world something in its day which will be as important as the automobile, the radio, the telephone, and the electric light.

But war comes. These people are young. They have had no chance to exercise their abilities. Men and women of ability, great and small, are struck down together. If their deaths destroyed only the investment required to feed, clothe and educate them, it would not be such an irreparable loss. But it has taken more. It has destroyed everything that these men and women, the average and the geniuses, could have given to the world.

In actual loss of life, plagues have been many times more destructive than war. The Black Death that swept over Europe in 1600 A. D. and the two waves that followed at 25-year intervals, killed perhaps a third of all the population of Europe.

Smallpox at one time was responsible for the loss of almost half the population of Iceland. In the war with Spain in 1898, the United States lost more men from typhoid fever than from fighting. The "flu" epidemic during the World War caused the death of 24,664 officers and enlisted men, from April, 1917 to December, 1919.

Plague and pestilence are steady workers and the sum of their labors over a period of years is appalling. They are still not so generally devastating as war, however, since these do not weaken the remaining population and overturn the entire natural life as war does.

Accidents as a whole in this machine age now kill more of our working people annually than both plague and war. Care in avoiding needless accidents will be discussed later.

But a man need not be killed, or even injured, to lose his earning and productive ability. If he is mentally disturbed and ill at ease, his capacity to do effective work may be more seriously injured than if he had broken his leg. It is only when he is in

Man power, if it is to be efficient, must not and can not remain idle. Only the human resource is injured through lack of use.

a happy, contented frame of mind that he is really mentally healthy and can do his best work. The social health of the community in which a man lives is almost as important in its effect on his usefulness as is the health of the man himself.

For still another reason man power is perishable. The very nature of the resource and of time does not permit man power to be stored as may be done with timber, wildlife, minerals, soil, and grasslands. The value of man power lies only in its day-to-day use. If a man does not work today, he can not make it up by doing twice as much tomorrow. If he could, he would not be doing his best. Man power can not be re-used if its energy has been improperly or unwisely spent; ten hours of loafing, or ten hours of building a drainage ditch where one should not be, are lost beyond recovery. This fact is a very important reason for keeping man power constantly productive.

There are several characteristics of the human resource. First of all, man power deteriorates and becomes less valuable through idleness. Left to itself the forest grows and improves in value. Soil is slowly enriched by lying unused. Minerals retain their value even if left in the earth for ages. Man power alone, of all the resources, must not and can not be allowed to remain idle and unproductive for any indefinite period.

Natural resources have value as they are useful in providing man with a living and keeping him happy. Some are worth more for recreation.

In order to be productive, man power must be at active work or engaged in satisfying recreation. Continuous work grinds a man down. He tires in both body and mind until the night's rest can no longer repair him for the next day's work. Whoever invented the old adage that "all work and no play, makes Jack a dull boy" knew what he was saying. Recreation is almost as important a part of the workingman's life as his meals.

There is a difference between recreation and mere idleness or loafing. To be sure, a man may be idle during his period of recreation, but it is for a certain purpose and for a certain time. It is idleness without purpose that injures the human resource. We shall see later the very important part that recreation plays in human lives, and how it makes man power more productive.

Fitting for Wise Use

Human resources are like natural resources in several respects. All may be made more valuable through careful planning and supervision. All may be wasted by neglect and misuse. Both human and natural resources may be put to higher uses. The man who has been digging ditches with a pick and shovel may be able to turn out the work of twenty men when he operates a powerful steam or electric shovel. His energy is put to a higher use and his production is increased twenty times.

In several respects, the human resource is unlike the other natural resources. It has been pointed out that man power can not be stored or re-used. Lost time is completely wasted and nonrecoverable. Man power can not remain unproductive very long without injury.

Human resources have an intimate relationship with other natural resources. The value of other resources such as minerals, soil, water, forests, grassland and wildlife, depends entirely on their usefulness to man. Iron was of no value to the primitive man of the stone age, because he did not understand how to use it. Because it now serves him in a thousand ways, it has become one of his most valuable possessions.

Exactly the same is true of the other resources. Each one takes on value only in proportion to how much service it can add to making man power more efficient and happy. The better a natural resource serves mankind, the more valuable it is. We

conserve our natural resources so that future generations may be better served by them.

Since the human resource is both so valuable and so perishable, it must be very carefully nurtured. Just how is this conservation going to be done? How can the wisest use be made of human energy?

Education is the most important means of making man power effective. Compulsory education has been the national policy of this country for over fifty years, and during that time America has come to rank among the top nations in literacy.

Vocational, trade, and business schools are comparatively new, having been developed widely only in the last two decades. A hundred years ago, a boy who entered a trade did so as an apprentice, which meant that he worked for several years in a shop and received no pay except his bed and board. The training of an apprentice was disappointingly slow.

Now trade and business schools are fitting boys and girls throughout the nation to become printers, mechanics, photographers, cabinetmakers, engineers, electricians, bookkeepers, secretaries, accountants, and other skilled workers. Trade schools are right in saying that there is almost always a strong demand for highly skilled labor; unskilled labor is most often hard to sell and brings a much lower price. Such a statement could be made in China, for example, where some of the highly trained research workers are paid salaries to compare with average wages here. Common laborers earn what would amount in our money to as little as three cents a day.

But any training to improve a man's value is lost unless the man has sound health. Nothing will reduce a man's efficiency more quickly than poor health. If he is not well fed, a man will lack the strength to turn out a good day's work. Children who grow to maturity without enough nourishing food are undersized, weak, and subject to illness that hinders them in their work. People who are poorly housed are more likely to suffer from diseases and weak bodies.

Great progress has been made in the last half century towards keeping the nation healthy. Smallpox used to wipe out whole communities until vaccinations largely put a stop to its ravages. Serums have been developed to prevent scarlet fever,

measles, mumps, and whooping cough. Others have largely minimized the danger of pneumonia. Diphtheria has been successfully blocked. The two drugs, sulfanilamide and sulfapyridine, have opened up a new field of medicine that may be said to be revolutionary, and penicillin has extended that field still further.

Working hours are another important factor in preserving a man's health. A hundred years ago men were usually at work from sunrise to sunset, working twelve hours a day without let-up or vacation. Some textile mills required that women and children start work at 4:30 in the morning. Carpenters in Washington, D. C., in 1833 stood at their benches from 15 to 17 hours. Under such conditions, with no time for recreation and rebuilding a tired body, health can not possibly be maintained. Hours of work in most cases have now been practically cut in half.

All that has been so far discussed has dealt with physical health. Mental health is even more important because it sometimes passes by unnoticed, is harder to judge, and harder to cure.

Poor mental health may be caused by dissatisfaction with a job, whether it be wages, type of work, or hours. It is a disease of sanity, since it greatly hinders work, and the discontent can readily spread from man to man. When a man is discontented with his work, he becomes sullen and unhappy, and a most unsatisfactory workman.

One who can look forward to an improvement in position and wages if his work is well done is most often happy with his work and in good mental health. One who can not see betterment ahead in wages or position is very often unhappy, and can not have a healthy outlook.

Social health is another factor that must be taken into account in considering the best care of our man power. The people in a community should live together in harmony, like the trees in a forest community. Each man should profit from the others, and, in turn, offer strength and help to his neighbors. Each should be employed and at wages that will keep him from being a burden on his neighbors. Society ought to supply the opportunity for good mental and physical health and spiritual development. There should be no fear of losing a job if the work has been well done. Worry over keeping a job is a great source of unrest.

When a society becomes unhealthy an increase in crime usually follows. Poor pay often leads to resentment, petty thefts sometimes follow and soon lead to robbery and more serious crimes.

Social health is dependent, too, upon many of the problems already discussed. Inadequate housing almost inevitably leads to child delinquency, and child delinquency is a symptom of an ailing society. When a society is healthy, children are not called upon to do unsuitable labor, and boys and girls grow strong and healthy and become worthy citizens. Child labor is often a force in developing physical weakness in young people.

Man power it has been said must not remain unproductive. There are two problems to be solved in keeping man power from rusting through disuse. The first is how to keep him employed throughout the year. The second is how to educate him to make good use of his leisure time through recreation. Wise recreation is important enough and deserves detailed discussion.

Recreation

The word "recreation" is meaningful. It comes from the verb "re-create," to refresh or to build anew. That is what recreation actually means—a rebuilding of a tired body so that it may better begin a new day. Leisure properly spent restores a body to better health. But just as soon as the purpose of the idle period is lost sight of and becomes one of indefinite length, the vacation degenerates into mere loafing, and time is wasted.

Recreation is intimately related to all the other natural resources. Why should our natural resources be preserved? Because they make it possible for a man to make a living so that he has leisure time to devote to recreation. They give him not only wealth and property, but they also give him pleasure. The quiet strength of forests, the rolling expanse of grassy prairies, and the friendly familiarity with wildlife, all add to man's pleasure and enable him better to stand the strain of industrial modern life.

When soils are kept from washing, the grass on hillsides is thicker, greener, and more pleasing. Streams that do not carry silt will run deep, cold and clear, and abound in fish. No dust storm will spoil the air. A water supply that is carefully guarded

keeps brooks running full throughout the year. Forests, if properly managed, will support a crop of wildlife and wild flowers for the enjoyment of all who love the out-of-doors. A plentiful iron supply helps to make available the cheap automobile by which man can enjoy the varied beauties of his country.

Were it not for the care that is taken of game and fish, there would soon be no inducement for hunters and fishermen to get back to nature.

All the natural resources help to make possible more and better recreation; and better recreation makes for better workmen.

One hundred and fifty years ago a man spent 12 to 14 hours a day, twelve months in the year, to make a living. Very often it was a poor living, with scarcely enough to keep his family in food, clothing, and a home. It was said that 12-hour days were necessary to keep workers from immoral living. Today the average man in this country works less than eight hours a day, and there is constant agitation to reduce the time still further. Leisure time has increased fourfold.

If man is to enjoy to the fullest this newly-earned leisure time, he must have more room and better equipment for play.

Near large cities, particularly, there is an urgent need for development. With a constant movement citywards during the last half century, each person has less room for activity. At present, 47 million people, about one third of the total population, live on two tenths of one per cent of the land.

In cities the need for space ought to change the character of parks from "Keep Off the Grass" plots to spots where tired mothers can lie on the grass and watch their youngsters play. Cities can hardly do better than spend money for well-equipped playgrounds and recreation centers. A few provide outdoor opera, music, and other forms of entertainment.

Now some people can afford to go farther than the city parks for recreation. On week ends and vacations they can travel into the country. Often states and counties have created public picnic and camp grounds in attractive locations. Many privately owned parks can be enjoyed at low cost. Our national and state forests, national and state parks, game refuges, public hunting grounds, and other forms of public domain furnish inexpensive places

Peasants used to spend long hours in wearisome toil. Even today in some foreign countries, man power is poorly, almost cruelly used.

where the average family of the nation can play. In some of the older countries of Europe, where all the lands are in private hands, hunting and fishing are only for those who own wide estates.

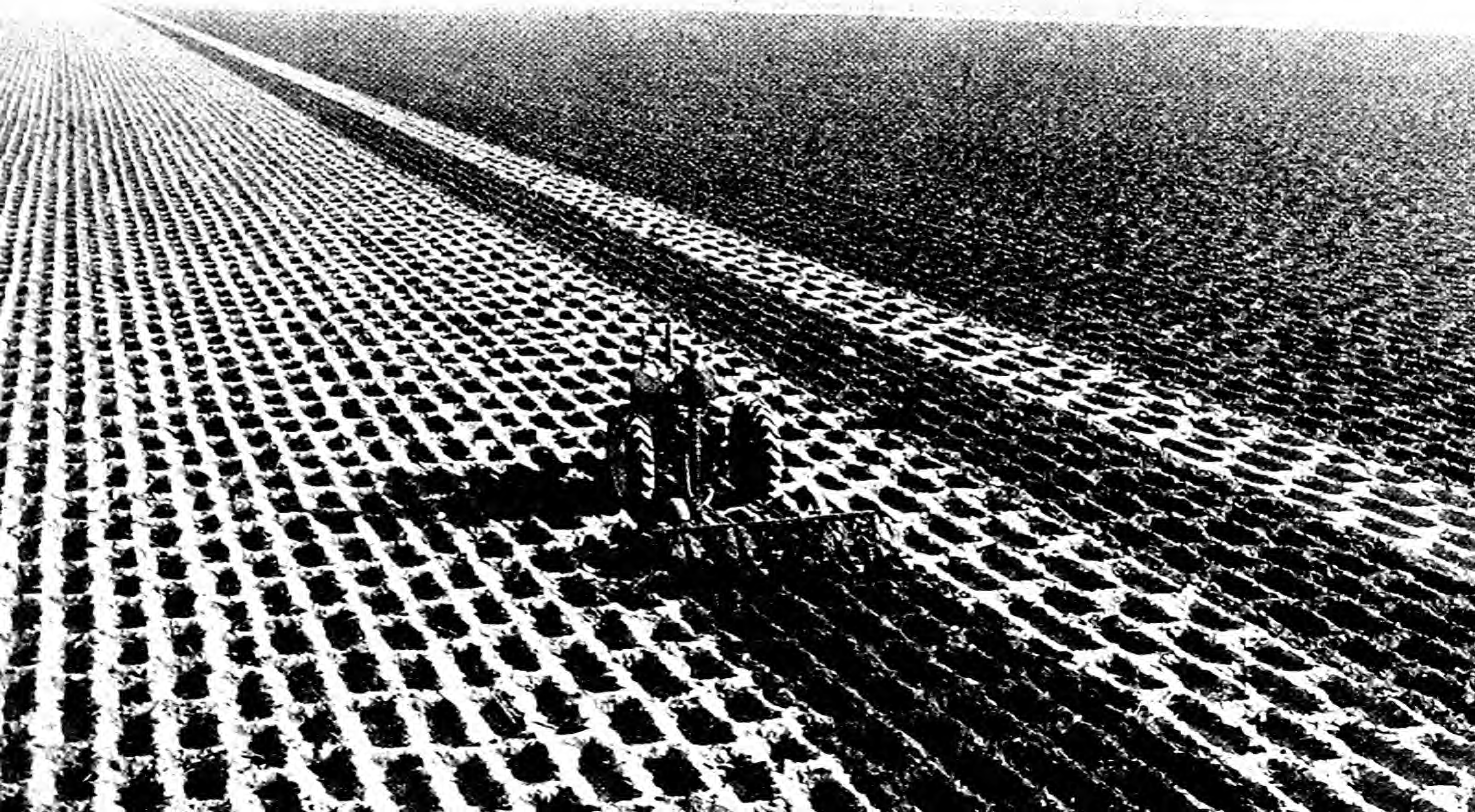
The establishment of every park, refuge, or public forest should be looked upon as a real gain to all society. John Stuart Mill, a famous economist, said that the more that is spent for recreation, the less is spent for crime, disease, and insanity. He also stated, years ago, that, if man must use so much of the earth to make his living that he no longer has a neighboring woods to wander in, or a friendly stream to explore, then he had better not be on the earth.

With over 150 million acres of national forests, 26 national parks, 72 national monuments, and several hundred state parks and other recreational areas, the country is fairly well supplied. Many millions of people take advantage of these areas every year.

Parks and forest preserves should furnish more than camping and picnic grounds. In many places they are equipped with

Men have higher uses, and brains can be made to take the place of muscles. Horses are cheaper sources of power than men.

Iron and petroleum have released man power from much of its backbreaking work. One man's labor today is worth many times what it once was.



More than half the occupied hospital beds in the United States are assigned to patients suffering from nervous and mental diseases. Many cases might have been avoided had the patients been taught how to use their spare time in healthful play. In the last 150 years man's leisure time has increased four times. In reserves such as Glacier Park, man's chances for recreation are safeguarded.

apparatus of many kinds for the use of children and grownups. In parks there should be swimming beaches and diving rafts.

It is estimated that the tourist trade, alone, brings into some states over a hundred million dollars a year. More than thirty million tourists visit the National Forests annually.

The United States is fortunate in that 45 per cent of its people live within a distance of 55 miles from the ocean or the Great Lakes. If less of the beaches along the coast and lake fronts were privately owned, the average man would be better off. If our water power developments were not controlled by the Government, hundreds of our scenic waterfalls that now attract tourists into the open, would be destroyed by commercial development.

The constantly growing need for recreational facilities is being recognized. Factory work is becoming more specialized.

The assembly line in volume production plants has tied men down to more exacting and nerve-shattering work. Recreation for both men and women is now extremely necessary.

Throughout much of the country, child labor laws now keep young people from working, and that increases the need for more recreational facilities. Teachers at public playgrounds are helping children to play hard and fairly. Parks in the suburbs of the cities are equipped with picnic grounds, tennis courts, and ball fields.

Organizations for boys and girls are the finest way of spending leisure and learning at the same time. Warden Lawes, of Sing Sing, has said that 90 per cent of his prisoners were never associated with any boys' clubs that might have shown them how to use their leisure time. They did not know how to play and turned to crime for something to do.

Today there is some kind of club available to every boy and girl in the United States. A few of the more important ones are: Boy Scouts, Girl Scouts, Camp Fire Girls, 4-H Clubs, Future Farmers of America, Young Men's and Young Women's Christian

Boys' and girls' groups emphasize the value of play. Many help teach the need for conservation.

Historic spots are valuable and must be preserved. Here is the Cliff Palace in Colorado where once lived part of a tribe of early Indians.

Associations, and the fine clubs that surround city settlement houses. Such groups do much to conserve the human resource.

Employment

Steady employment is the second factor to consider in keeping man power productive. Do you realize the power that is going to waste for lack of employment? Think what the idle men you can see in the street in one afternoon could do if they were put to work on your father's farm or in the school yard! What could 30 men do towards cleaning up a whole city, or building a fine apartment house where now there are slums?

In the United States there have been not thirty, but as many as fourteen million such unemployed men. And they have been idle, not for one day, but a great many of them for a year or more. As yet no one has been able to plan how they might be employed.

With but few exceptions, these idle men do not like to be unoccupied. In fact, society, by enforcing inactivity, imposes punishment upon wrongdoers that is somewhat akin to unemployment. Idleness is inflicted on many men because society has not yet learned how to plan its work to last the year around.

Formerly, there was space necessary for expansion and an outlet for all the excess labor that resulted from a rapidly growing population. For three centuries, the frontier served as a safety valve to care for all the unemployed. When a man could not find a job at home, he traveled west. Now there is no longer a frontier, and unemployed men walk the streets seeking work.

Occasionally a new invention opens up a field that takes care of the surplus man power, just as the automobile industry has done for the past twenty years. Some have thought that air conditioning, or a like improvement, might take up unemployment slack in the near future.

Society has not yet recovered from the worst depression that the world has ever known. Unemployment has raged like an epidemic.

The Government from 1933 on has been spending money on a program of public works in an attempt to keep men busy till they can again go back into private industry. The CCC camps have been used to give employment to boys of working age. Unemployment insurance and old-age pensions have been introduced. Now, however, the national defense program calls for great numbers of technicians, mechanics, and other forms of service.

Several private firms have developed plans to keep men at work. Because its industry is more or less seasonal, one meat packing firm pays its men on a twelve-month basis, even though they work only half the time. Wages are distributed evenly and men feel secure. The employer tries hard to make work more steady.

There is now a number of special social problems that must be considered singly. Each determines an important part of how well the human resource may be used and conserved.

It is not yet known just what proportion of a man's time should be spent in work and what in pleasure. Working hours have been the basis of many strikes and walkouts. It is known, however, that too long hours do not pay. Some executives have found that by changing from two twelve-hour shifts to three eight-hour shifts, production has been speeded up and the costs have been actually decreased. Less time, however, has been lost through accidents, sickness, and loafing, and men usually work harder under the better conditions.

One man with a cradle could cut two acres in a 12-hour day.

To safeguard men from working too long hours, the Government has enacted laws regulating working hours and minimum wages. It specifies the maximum number of hours that men in different classes can be required to work and the minimum wages that may be paid.

In Massachusetts between 1830 and 1860, men earned about five dollars a week and women less than half as much. This wage was barely enough to keep children from starvation.

It is not uncommon to hear a comparison foolishly made between the present working day and the old working day to show how lazy modern man is becoming. That is bad thinking. Machines have made man power many times more effective than it used to be; but their use has meant that a man had to concentrate harder, work more intensely and do a greater volume of work in much less time.

It is not enough, however, to know the daily wage. One must know also the average number of weeks that a man is likely to work during the year. With proper wages, a man's health is likely to be good, because both he and his family are well cared for and have security against hard times. Man power then operates at its peak.

With a 10-foot combine, one man can now cut and harvest 25 acres in a 10-hour day. When inventions change the course of industry, mankind eventually is always the winner.

Improper housing, often the result of too low wages, cuts down the efficiency of workers. We have noticed that this condition tends to increase crime. It makes people discontented and unhappy. Very often, dingy, foul rooms and unsanitary conditions are overlooked until they give rise to a dangerous epidemic. The Federal Government is to be congratulated whenever it clears slums and creates lighted modern apartment buildings.

The other social problems just mentioned—a fair arrangement of working hours, adequate wages and good housing—are important to study thoughtfully. Man must be happy to work, and he must work to be happy. He must come from a clean, airy home knowing that his family is well fed and sheltered.

Man power should be so treated that it becomes an ore worth working, like a mineral resource. There might be an abundance of ore in the mine, but it may be of such poor quality that it is scarcely valuable. So, man power may be plentiful, but of such poor quality due to overwork, underpay and the consequent physical and mental ill-health, that it can scarcely be used profitably

Another problem, that of aged labor, is of rather recent origin. During the last depression, we often heard the statement made that old men were being thrown on the "scrap heap." There has been a tendency for factories to hire young men in preference to middle-aged or aging men. Fast machines demand quicker operators.

This tendency may be a necessity; but, if so, a workman must be allowed to provide for his old age, either through savings or some kind of old age insurance. Nothing will do more toward creating unrest, and hence interfering with efficiency than worry over a destitute old age. If his old age is provided for, a man can devote his whole energy to the job in hand. Freedom from care promotes greater efficiency.

Child labor is still a problem that worries the nation. It exists wherever there are factories, especially in the South, and on farms. Child labor often leads to broken health and stunted intelligence. In spite of tremendous efforts to prevent it, many children are still being worked beyond the limits of their strength. Most states now prohibit children under 14 from working in factories. Some states compel school attendance through the grades.

Heavy immigration, especially since the turn of the century, has added another labor problem. Immigrant labor adds to the sum total of our human resources, but it often comes to us completely unskilled. Man power that is untrained, it has been said, very often has difficulty in finding employment.

In any nation a population must build upon its natural

The growth of great cities has added to the problems of wise use of man power. Where can cities find pure drinking water? How can they keep free from disease? Where will there be room for recreation? A city and its crowded millions must be kept healthy and happy.

resources. The human resource must be divided into the sum total of natural resources. If the resulting number is too much smaller than it would be without immigration, the result to persons already in the country is probably harmful. But often well-trained labor can make natural resources more valuable. It is hard to find the best proportion of population to food and raw materials, but there is such a thing.

Industry has already done much to prevent both disease and deaths from accident of men at work. Here the damaging coal dust is being settled by a stream of water.

Industrial Diseases and Accidents

In every industry and business certain accidents and disease may result directly or indirectly from the occupation and become a major problem of conservation.

One industry in a southern state reported that it had to keep five men on the pay roll for every two that were needed at work. Malaria, hookworm, typhoid, smallpox and other diseases were to blame. In other words, man power was only one fifth as efficient as it would have been without these handicaps. If these men had kept their health, they would all have been five times better off.

Besides such diseases, which are common to everyone, there are others that depend particularly on the kind of employment. Men in mines and in mills are especially susceptible to pneumonia and other lung diseases. Workers in factories where much lead is used are subject to lead poisoning. Until recently coal

Accidents never just happen. Every one has a cause, and most can be prevented. Here a welder is carefully protected from sparks.

miners were overcome by the dust and suffered severely from pneumonia and tuberculosis. Men in flour mills suffer from the dust. The past tense can now be used in referring to most of these diseases because remedies have been largely applied. Employers are so strongly convinced that the health of their employees is vital to the success of their business that they are in many cases pushing remedies faster than the men themselves are willing to go.

Accidents in industry are another important problem in conservation. Too many people are likely to think that accidents "just happen." As a matter of fact each one has a definite cause. Almost every one can be prevented if precautions are taken to have all dangerous machinery heavily guarded, mines properly timbered, and common rules of safety applied.

Accidents in factories are not uniformly scattered throughout the week. A careful student could almost predict when they are most likely to "happen." They come toward the end of a long shift when men are tired. Many can be traced to the use of alcohol. Accidents are also very likely to occur when men are worried or mentally depressed. Large companies now hire physicians to care for their sick and injured. Safety inspectors try to determine where accidents are likely to occur.

Probably the greatest impetus to progress has been the workmen's compensation law that throws the burden of expense in case of accident upon the employer. It has caused the factory owner to install a great many safety devices, to institute safety schools for employees, to allow rest periods, to shorten hours and to furnish facilities for proper relaxation.

Regardless of such progress there are tremendous and unnecessary losses. In New York State alone there were half a million industrial accidents in 1937, and 1,452 deaths. More than 21,000 people were permanently injured. These losses have gone on for the last fifteen years with little sign that they are being made to shrink.

The subject of accidents in everyday life is too huge to discuss, but one phase might be mentioned. An insurance company points out that America since 1776 has taken part in six major wars which, in total time, extended over fifteen years. The number of American soldiers killed in action or dying from wounds

In spite of progress, a half million industrial accidents occur yearly in New York State. We are still a long way from safety at work. Here the masked man is taking part in a practice attempt to rescue miners.

during those fifteen years was 244,537, compared to an estimated total of 441,912 traffic deaths on American highways for the fifteen "years of peace" from 1923 to 1937.

If such accidents were unavoidable, the case might not seem quite so bad. A very large per cent, however, are caused by recklessness and disregard of the rights of others, and are, therefore, easily avoidable. Too many people drive on someone else's brains, taking a chance that the other fellow will get out of the way.

An old constable in a country village who understood traffic problems posted this sign: "Curve! Drive slowly! You might meet another fool!" Trying to pass when another car is approaching, rounding a corner on the wrong side of the road, driving too fast where there is poor vision ahead, parking on the pavement, making a left-hand turn from the right side of the road, turning without signal, stopping on a corner, driving with the left-hand wheels on the center line, cutting in on a car before one has really passed it—these are only a few of the serious errors that cause accidents.

Governments—Federal, state and local—have passed sane laws covering most of these phases. But there are several hundred thousand miles of highway and only a few patrolmen. Cutting down accidents and conserving lives must come from every man and woman playing according to the rules whether the referee is in sight or not. People who obey the law only when there is a chance of being caught are poor sports and might cheat at whatever they might be doing.

To curb accidents, man must be made to realize that an automobile, when it is carelessly used, is a more dangerous weapon than a gun. A man who kills another by careless driving is a murderer.

Much work needs to be done to clear crossroads on highways of surrounding brush and to make oncoming traffic visible. Railroad crossings should be clearly marked. It might well be the yearly project of an alert conservation class to study danger spots near its school or city and to take steps to do away with them. Many grade crossings are being eliminated.

In many accidents, pedestrians are to blame. There are still too many who do not look both ways before they cross the road, who dart out into the street without warning and walk on the

wrong side of the street with their backs turned toward oncoming cars. Pedestrians must share responsibility with drivers.

You may think that a good deal is expected of you as young people when you are asked to observe many of the rules for safety in walking, but try to remember that in a few years you will be driving the cars and will be worried because children do not look out for themselves. Put yourself in the driver's place and try to help him.

Altogether, drivers and pedestrians account for almost 40,000 deaths and several hundred thousand injuries in a year.

Machines and Men

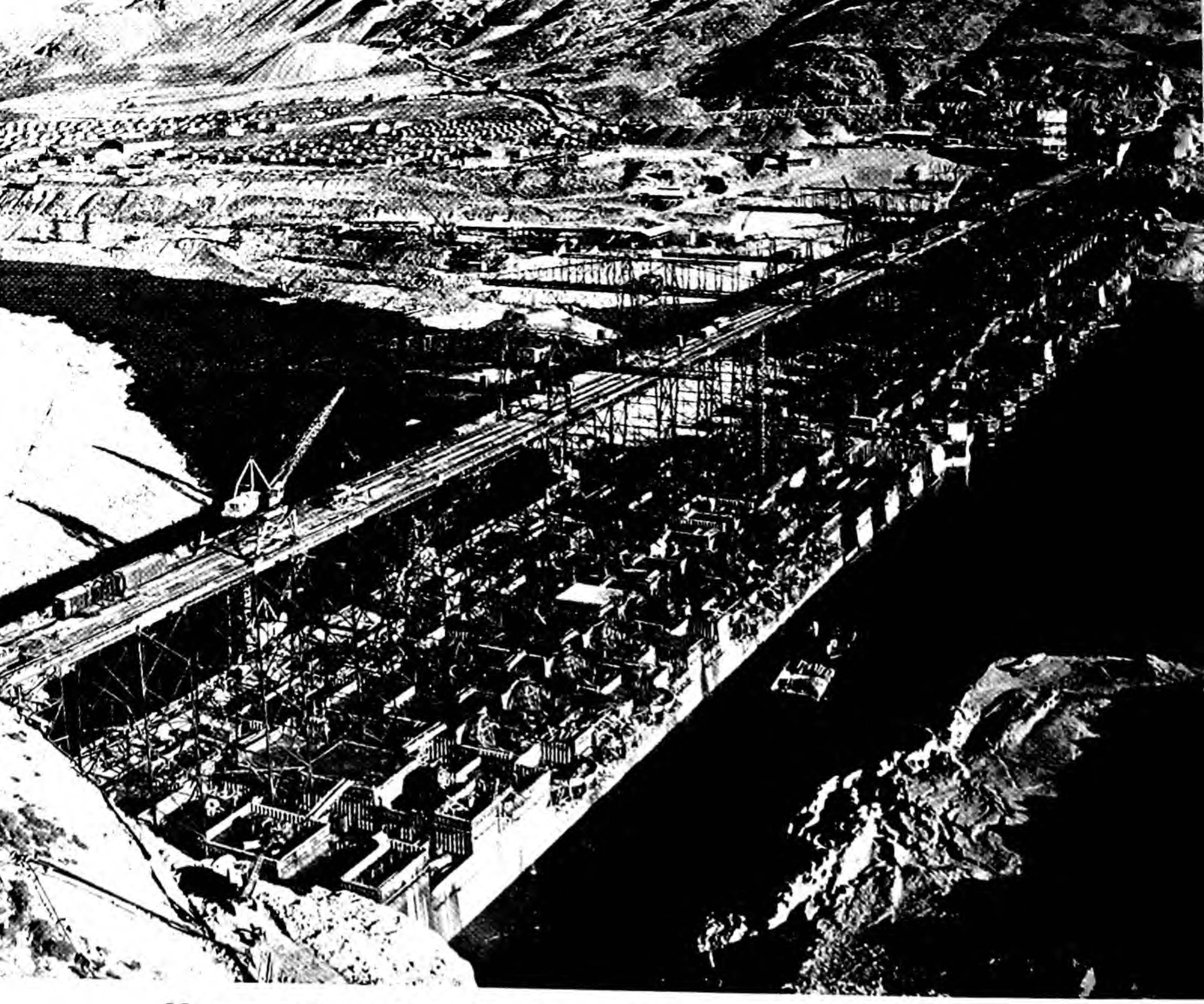
All through the study of conservation, we have talked about the fundamental practice of substituting cheaper materials whenever possible. We use a cheaper metal in place of a more expensive one—that is a gain to conservation. We use a less expensive wood where it can take the place of a costly and rare one. The same substitution must be exercised with men also, to put them to their highest use. A man should not be wasted on low grade work when he is capable of something better, or when a machine will take his place.

The Industrial Revolution gave men machines which made it possible for coal and electricity to take the place of human muscle. Thus, a gang of men that with pick, shovel, and wheelbarrow could dig a ditch for $100, could be substituted by a steam shovel that could dig the same ditch for $25 in less time. Then men were put to higher uses, perhaps set to work in an automobile factory where they earn $350 in the time it took to dig the ditch.

To be sure, a new machine almost always upsets the old order of things, and causes temporary hardships.

The introduction of machine looms into England a century ago caused riots among the old hand-weavers. They saw their jobs taken from them and feared that the starvation which had followed them all their lives, would now surely catch up. But it was not long until they were earning more than ever before. They noticed, too, that they spent less for cloth.

That is the way the introduction of machines has always worked out. Machines have released men for higher jobs. What



Man must learn to make his work count—and to work on worth-while projects. The Great Pyramid was long the world's largest masonry structure. Now it is greatly exceeded by Grand Coulee Dam, as high as a 46-story building, long as 14 city blocks. Yet the Great Pyramid required 2,000,000 man-hours of labor (100,000 × 20 years), the dam a fraction of that time. Grand Coulee Dam will help to control floods, furnish water for irrigation, and spread light and power for miles around. What good are pyramids?

those higher jobs are is difficult to say. Shall men build more and faster trains, or better and safer airplanes? One thing is fairly certain, however, that machines enable man to make best use of natural resources, and permit him the highest standard of living.

It is possible to think of man power as a great master machine that utilizes all the natural resources in the country, gathers them in as raw materials and turns them out as valuable,

finished products. On the efficiency and continuous operation of this machine depends the prosperity of the country. Wars, plagues, disease, accidents, mental depression, and social unrest are like so many monkey wrenches thrown into the gears. They slow down the machine and disrupt the flow of products and force the replacement of broken parts.

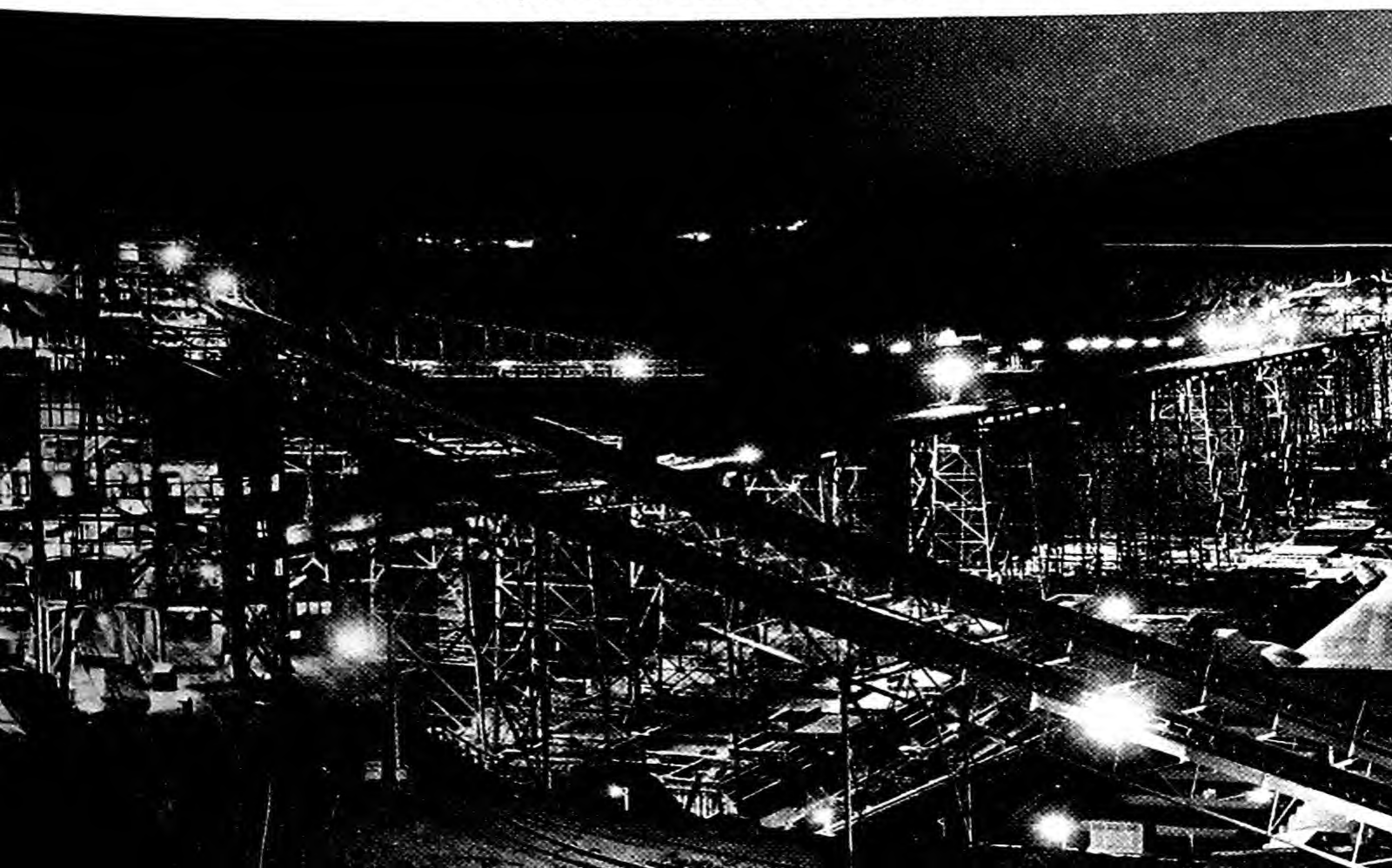
Just as those factors interrupt and harm the machine, so there are other factors that make it operate with perfect rhythm: plentiful resources managed on a sustained yield, men who are educated to serve their highest uses—these are oil to the great machine and make it hum.

Health through proper medical care, shorter hours, suitable recreation, and better housing tend to increase efficiency.

Social well-being through wise labor laws, steady employment, control of child labor and immigration, safeguards the body, cheers the mind, and protects the human machine.

America has made great progress in protecting and improving its man power. The American standard of living is the highest in the world. But there is still urgent need for improvement. Poverty and overwork are unnecessary. In a nation as rich as

Counting all the power at work, from the threshing machines to the giant turbines that supply energy for electricity, there is at work for every family in the country the equivalent of 120 horses working eight hours a day, six days a week for the entire year.



ours, no man and his family need go cold and hungry. Widespread unemployment, strikers battling police, mine disasters and disease, are headlines that ought to command every thinking man and woman to study and action.

The nation with the best man power is the nation that will live. Let us try to make our man power and our nation the best in the world. America needs the help of every one of us.

REVIEW QUESTIONS

1. For what reasons is the human resource more valuable in terms of dollars and cents than any other resource?
2. Explain why every boy and girl of high school age is in debt to society.
3. Which of the forces attacking the human resource has been most destructive?
4. In the last few years, what factor has been effective in destroying the largest share of the human resource?
5. Explain why mental health may be more important than physical health in allowing work to be done.
6. Explain why man power is especially perishable.
7. In what one way is the human resource most unlike the natural resources? How is it like them?
8. Explain the relation between the human and natural resources? Why is any resource valuable?
9. How may man power be made still more valuable?
10. Why must working people be kept in proper health?
11. Describe the causes for mental and social ill health.
12. How can you tell whether a nation's man power is in good mental and social health?
13. Give the reasons why recreation benefits the health of the human resource. Why is the problem more important now than formerly?
14. What has the Government done to safeguard future man power?
15. Why should a city or country community start youth groups?
16. What indication have you seen recently which indicates that man power has not been wisely used?
17. How have various industries and factories helped to overcome the evils of unemployment?
18. Describe the problem of wages and hours, particularly as they affect employers and employees.
19. Which problem is more important, aged labor or child labor?
20. Describe the progress that is being made in control of industrial disease and accidents.
21. Why is the topic of traffic accidents a good one for discussion?
22. What is likely the first result to man power when a new machine is invented? What will be the final result?

SUGGESTED ACTIVITIES

1. Study the effect of any one invention on man power. Find what adjustments were made necessary to keep replaced men at work.
2. Study the employment in your city or community. Which industries employ their men seasonally? Discuss with the class the problem of your own seasonal unemployment. Whose responsibility is it to keep men at work? How might the industry be managed to employ men the year long? Where else might the men work?
3. Learn from informed persons why men in your community are idle.
4. From a pioneer in your community, find what you can about working hours, wages, and general conditions in early times. What new problems have arisen that were not important fifty years ago?
5. Find all the information you can about settlement houses. If it is possible, one of the class should visit one, and report on its activities.
6. Find the per cent of people occupying hospital beds who are there because of nervous and mental disorders. How might this waste of man power be prevented?
7. Make a careful study of the accidents which have occurred in your community in the last year. Divide them into those in industry, those in the home, and traffic accidents. Decide after discussion with the class which of them were avoidable. What precautions might be taken to prevent them in the future?
8. Learn to enjoy the out-of-doors in order that you may better help others to enjoy it. Shut your eyes some day and try to identify all the sounds you hear. Note how many odors come to you as you walk over fields and through meadows. Find beauty spots in forests, along brooks, and in parks.
9. Survey your town or community for its hazards. They might be blind corners, abrupt turns, unguarded embankments, and scores of others. Take action as a class in removing them. Give life-saving and safety demonstrations. Conduct traffic schools for other grades.
10. Plan with the class a worthy job for the unemployed men and women in your community. Bring your suggestions to the proper local authorities.
11. Are there proper recreational facilities where people can enjoy themselves at little or no cost? Take steps to provide them, remembering all the while that they must be paid for.
12. Map out a proper working day for some industry near you, indicating what you believe to be an adequate wage. Study the industries from the wages and hours standpoint.
13. Find material about the agencies that are at work to help men and women adjust themselves to their daily living.
14. Improve some spot of natural beauty near your school. Perhaps it can be made into a park or wayside picnic grounds. Label the trees and shrubs in the vicinity.

Debate: Resolved, That inventions ought to be kept off the market until man power is ready for the change.

Appendix

Public Lands of the U. S.[1]

The "original public domain" in the United States comprised 1,442,200,320 acres of land and 20,232,320 acres of water, as follows[2]:

Treaty with Great Britain and state cessions following Revolution	266,427,520
Louisiana Purchase (1803)	529,911,680
Oregon Territory (by discovery)	183,386,240
Purchased from Spain (1819)	
Florida	37,546,240
West of Mississippi River	8,598,400
Mexican cession (1848)	338,680,960
Purchased from Texas (1850)	78,892,800
Gadsen Purchase (1853)	18,988,800
Total "original public domain"	1,462,432,640
Less water area	20,232,320
Total land area "original public domain"	1,442,200,320

The disposition of the "original public domain" to June 30, 1944, has been approximately as follows:

Title passed from the United States:	
Homesteads	285,000,000
Grants to States	225,000,000
Military bounties and private land claims	95,000,000
Grants to railroad corporations	91,000,000
Cash sales and other disposals	333,000,000
Total area disposed of	1,029,000,000
Unperfected entries	700,000

[1] Source: General Land Office, Department of the Interior.

[2] These figures are for 1912 and have not been corrected to conform with the new computations for land and inland water area made for the Census of 1940.

Title remaining in the United States:

National forests	138,000,000[3]
Grazing districts	131,000,000
Indian reservations	54,000,000
National parks and monuments	12,000,000
Military reservations	12,000,000
Miscellaneous	65,000,000
Total remaining and unentered	412,000,000
Grand total (computed area)	1,442,167,520

[3] For purposes of this table, which contains various classifications, the National Forests are listed at 138,000,000 acres. There are within the National Forest boundaries at this time approximately 180,000,000 acres. The other 42,000,000 acres are included in several other classifications.

National Forest Areas in 1942[1] by States

(Acres)

Alabama	2,435,087
Arizona	12,159,018
Arkansas	3,586,656
California	24,759,149
Colorado	15,158,355
Florida	1,241,955
Georgia	1,732,322
Idaho	21,503,158
Illinois	812,654
Indiana	781,467
Iowa	218,446
Kentucky	1,393,521
Louisiana	1,274,066
Maine	878,032
Maryland	4,318
Massachusetts	1,651
Michigan	5,150,564
Minnesota	5,038,531
Mississippi	2,777,325
Missouri	3,459,999
Montana	18,992,061
Nebraska	207,209
Nevada	5,305,242
New Hampshire	806,323
New Mexico	10,085,908
North Carolina	3,596,404
North Dakota	764,425
Ohio	1,466,109
Oklahoma	344,269
Oregon	17,284,792
Pennsylvania	746,703
South Carolina	1,422,604
South Dakota	1,403,915
Tennessee	1,531,797
Texas	1,714,374
Utah	8,954,120
Vermont	580,520
Virginia	4,123,663
Washington	10,743,917
West Virginia	1,836,140
Wisconsin	2,016,924
Wyoming	9,118,218
Total	206,411,911
Alaska	20,883,646
Puerto Rico	186,155
Grand Total	227,481,712

Of this grand total, 177,302,-149 acres are under Forest Service control.

[1] Source: U. S. Forest Service.

Areas Administered by the National Park Service in the Public Land States, as of June 30, 1944[1]

(Acres)

Alabama	8,768
Arizona	2,614,193
Arkansas	1,011
California	4,405,027
Colorado	546,626
Florida	9,624
Idaho	71,224
Illinois	2,522
Indiana	11,604
Louisiana	30
Michigan	150,054
Minnesota	18,614
Mississippi	11,119
Missouri	25,355
Montana	1,136,341
Nebraska	3,637
Nevada	672,634
New Mexico	243,768
North Dakota	63,618
Ohio	71
Oklahoma	3,140
Oregon	164,902
South Dakota	186,215
Utah	299,940
Washington	1,077,239
Wyoming	2,147,000
Total	13,874,276

[1] Source: General Land Office, Department of the Interior.

State Park and Recreational Areas, 1942[1]

(Acres)

Alabama	21,708
Arizona	7,797
Arkansas	14,822
California	316,527
Colorado	120
Connecticut	12,994
Delaware	
Florida	19,854
Georgia	11,218
Idaho	42,518
Illinois	11,452
Indiana	14,121
Iowa	18,779
Kansas	11,072
Kentucky	40,220
Louisiana	6,772
Maine	16,409
Maryland	3,151
Massachusetts	20,685
Michigan	39,047
Minnesota	45,341
Mississippi	9,737
Missouri	18,651
Montana	2,777
Nebraska	3,902
Nevada	11,500
New Hampshire	42,631
New Jersey	18,844
New Mexico	4,794
New York	2,562,971
North Carolina	28,740
North Dakota	3,309
Ohio	19,266
Oklahoma	34,464
Oregon	20,068
Pennsylvania	30,692

[1] Source: U. S. Forest Service.

Rhode Island	7,380	Virginia	18,304
South Carolina	22,861	Washington	44,804
South Dakota	108,640	West Virginia	29,599
Tennessee	8,732	Wisconsin	12,409
Texas	308,978	Wyoming	1,238
Utah			
Vermont	5,383	Total	4,055,281

Lumber Produced in 1943 by States[1]

(1000 ft. b. m.)

Alabama	2,141,832	Nebraska	7,530
Arizona	151,547	New Hampshire	392,332
Arkansas	1,449,842	New Jersey	30,402
California	2,352,592	New Mexico	109,099
Colorado	89,479	New York	270,603
Connecticut	21,071	North Carolina	1,579,833
Delaware	21,551	Ohio	276,276
Florida	507,103	Oklahoma	95,695
Georgia	1,856,585	Oregon	6,401,424
Idaho	889,748	Pennsylvania	447,046
Illinois	91,659	Rhode Island	3,513
Indiana	156,081	South Carolina	1,001,140
Iowa	53,956	South Dakota	45,064
Kansas	20,942	Tennessee	767,540
Kentucky	531,212	Texas	1,129,018
Louisiana	1,082,230	Utah	26,722
Maine	288,084	Vermont	138,337
Maryland	131,942	Virginia	1,098,070
Massachusetts	95,983	Washington	4,490,086
Michigan	406,959	West Virginia	655,048
Minnesota	195,658	Wisconsin	391,466
Mississippi	1,634,004	Wyoming	47,871
Missouri	291,062		
Montana	423,520	Total	34,288,757

[1] Source: U. S. Bureau of Census and Federal Forest Service.

Farms in U. S., 1940[1]

Number	Area (acres)	Value
6,096,799	1,060,852,374	$33,641,738,726

[1] Source: U. S. Bureau of Census.

Chief Crops in the U. S. in 1941[1]

Crop	Acres (1,000)	Production (1,000)	Farm Value ($1,000)
White Potatoes	2,711	355,602 bu.	$287,009
Sweet Potatoes	746	62,144 bu.	58,443
Cotton	22,236	10,744 bales	914,196
Tobacco	1,306	1,262,049 lbs.	333,103
Corn	86,186	2,675,790 bu.	2,008,881
Wheat	55,642	943,127 bu.	890,832
Oats	37,965	1,180,663 bu.	484,429
Rye	3,570	45,364 bu.	24,449
Barley	14,220	362,082 bu.	191,285
Buckwheat	337	6,038 bu.	4,072
Flaxseed	3,275	32,285 bu.	57,735
Rice	1,214	51,323 bu.	69,600
Apples		122,742 bu.	
Peaches		74,364 bu.	
Pears		29,530 bu.	
Citrus fruits		5,516 tons	

[1] Source: Estimates by U. S. Department of Agriculture.

Developed Water Power in U. S. by States, as of January 1, 1941[1]

(H. P. in 1000s)

Alabama	1,145
Arizona	427
Arkansas	95
California	2,438
Colorado	111
Connecticut	179
Delaware	1
District of Columbia	6
Florida	22
Georgia	598
Idaho	393
Illinois	94
Indiana	53
Iowa	207
Kansas	13
Kentucky	151
Louisiana	0
Maine	638
Maryland	404
Massachusetts	389
Mississippi	0
Michigan	534
Minnesota	262
Missouri	247
Montana	502
Nebraska	120
Nevada	709
New Hampshire	479
New Jersey	16
New Mexico	36
New York	1,844
North Carolina	1,033
North Dakota	0
Ohio	25
Oklahoma	3
Oregon	588

[1] Source: Federal Power Commission.

Pennsylvania	607
Rhode Island	25
South Carolina	839
South Dakota	19
Tennessee	694
Texas	120
Utah	143
Vermont	268
Virginia	282
Washington	1,215
West Virginia	308
Wisconsin	515
Wyoming	70
Total	18,867
Alaska	46
Hawaii	32
Philippine Islands	27
Puerto Rico	43
	148
Grand Total	19,015

Mineral Production in the U. S., 1943[1]

(Producing states in order of importance. Starred entries indicate order in value; those unstarred, order in quantity.)

Aluminum: N.Y., Wash., Tenn., Ark.
Andalusite: Calif.
Antimony ore: Idaho, Ore., Alaska, Nev.
Aplite (crude): Va.
Arsenious oxide: Mont., Utah.
Asbestos: Vt., N.C., Ariz., Calif.
Asphalt:
- Native: Texas, Okla., Ky., Utah
- Oil: Not separable by states

Barite (crude): Mo., Ga., Ark., Tenn.
Bauxite: Ark., Ala., Ga., Va.
Bismuth: Not separable by states
Boron minerals: Calif.
Bromine: N.C., Texas, Mich., Calif.
Cadmium: not separable by states
Calcite (Iceland spar): Calif., Mont.
Calcium-magnesium chloride: Mich., W.Va., Calif., Ohio
Cement: Penn., Calif., Texas, Ala.
Chromite: Mont., Calif., Ore., Alaska
Clay:
- Products (other than pottery and refractories): Ohio, Penn., Ill., N.J.*
- Raw (sold or shipped by producers): Penn., Mo., Ohio, Ga.

Coal:
- Bituminous: W.Va., Penn., Ill., Ky.
- Pennsylvania anthracite: Penn.

Cobalt: Penn.
Coke: Penn., Ohio, Ind., Ala.
Copper: Ariz., Utah, Mont., N.M.
Diatomite: Calif., Ore., Nev., Wash.
Emery: N.Y.
Feldspar (crude): N.C., S.D., N.H., Colo.
Ferro-alloys: Penn., N.Y., Ohio, W.Va.

[1] Source: The Bureau of Mines.

Fluorspar: Ill., Ky., Colo., N.M.
Fuller's earth: Texas, Ga., Ill., Fla.
Garnet (abrasive): N.Y., Idaho, N.C.
Gold: Utah, Ariz., Calif., Nev.
Graphite:
  Amorphous: R.I., Nev.
  Crystalline: Ala., Texas, Penn., Mont.
Grindstones and pulpstones: Ohio, W.Va., Wash.
Gypsum (crude): N.Y., Mich., Calif., Iowa
Helium: Texas
Indium: Not separable by states
Iodine (natural): Calif.
Iron:
  Ore: Minn., Mich., Ala., Wisc.
  Pig: Penn., Ohio, Ind., Ill.
Kyanite: Va., N.C., Ga., Calif.
Lead: Mo., Idaho, Utah, Okla.
Lime: Ohio, Penn., Mo., W.Va.
Lithium minerals: S.D., N.C., Calif., N.M.
Magnesite (crude): Wash., Nev., Calif., Texas
Magnesium: Texas, Nev., Ohio, Mich.
Magnesium compounds (natural): Texas, Mich., Calif., Nev.
Manganese ore: Mont., Calif., Nev., Wash.
Manganiferous ore: Minn., Mich., N.M., Va.
Manganiferous zinc residuum: N.J.
Marl:
  Calcareous: Va., Minn., Mich., Ind.
  Greensand: N.J.
Mercury: Calif., Ore., Nev., Idaho
Mica: N.C., Ga., Calif., Colo.
  Scrap: N.C., Ga., Calif., Colo.
  Sheet: N.C., N.H., S.D., Ga.
Mineral pigments:
  Natural pigments and manufactured iron oxide pigments: Penn., Ill., N.J., Va.
  Lead and zinc pigments: Penn., Ill., Kans., Ohio
Molybdenum: Colo., Utah, N.M., Calif.
Natural gas: Texas, La., Calif., Okla.
Natural gasoline and allied products:
  Natural gasoline and cycle products: Texas, Calif., Okla., La.
  Liquefied petroleum gases: Texas, Ill., Okla., Calif.
Nickel: Not separable by states
Oilstones, etc.; Ark., N.H., Ohio, Ind.
Ores (crude), etc.:
  Copper: Ariz., Utah, Nev., N.M.
  Dry and siliceous (gold and silver): Alaska, Colo., Idaho, Nev.
  Lead: Mo., Idaho, Calif., Utah
  Lead-copper: Ariz., Idaho, Colo., N.M.
  Zinc: Okla., Kans., Tenn., Mo.
  Zinc-copper: Wash., Ariz., Calif.
  Zinc-lead: Okla., Kans., Idaho, Mo.
  Zinc-lead-copper: Ariz., Utah
Peat: Ill., N.J., N.Y., Penn.

Pebbles for grinding: Texas, Minn., Wisc., N.C.
Petroleum: Texas, Calif., La., Okla.
Phosphate rock: Fla., Tenn., Mont., Idaho
Platinum metals: Alaska, Calif.
Potassium salts: N.M., Calif., Utah, Md.
Pumice: Kans., Calif., Nebr., N.M.
Pyrites: Tenn., Calif., Va., N.Y.
Salt: Mich., N.Y., Ohio, La.
Sand and gravel: Calif., Ill., Texas, Ohio
Selenium: Not separable by states
Silica (quartz): Wash, Calif., Wisc., N.C.
Silica sand and sandstone (ground): Ill., N.J., Ohio, Penn.
Silver: Idaho, Utah, Mont., Ariz.
Slate: Penn., Vt., N.Y., Me.*
Sodium salts (carbonates and sulfates) (natural): Calif., Tex., Wyo.
Stone: Penn., Mich., Ohio, Ill.
Strontium minerals: Texas, Calif., Ark., Tenn.
Sulfur: Texas, La.
Sulfuric acid from copper, lead, and zinc smelters and zinc roasters: Penn., Ill., Tenn., Ariz.
Talc, pyrophyllite and ground soapstone: N.Y., N.C., Calif., Vt.
Tellurium: Not separable by states
Titanium concentrates:
Ilmenite: N.Y., Va., Fla., N.C.
Rutile: Va., Fla., Ark.
Tripoli: Ill., Mo., Okla., Ark.
Tungsten ore: Idaho, Calif., Nev., Colo.
Vanadium: Colo., Utah, Ariz., N.M.
Vermiculite: Mont., S.C., Colo., Texas
Zinc: Okla., N.J., Idaho, N.M.

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